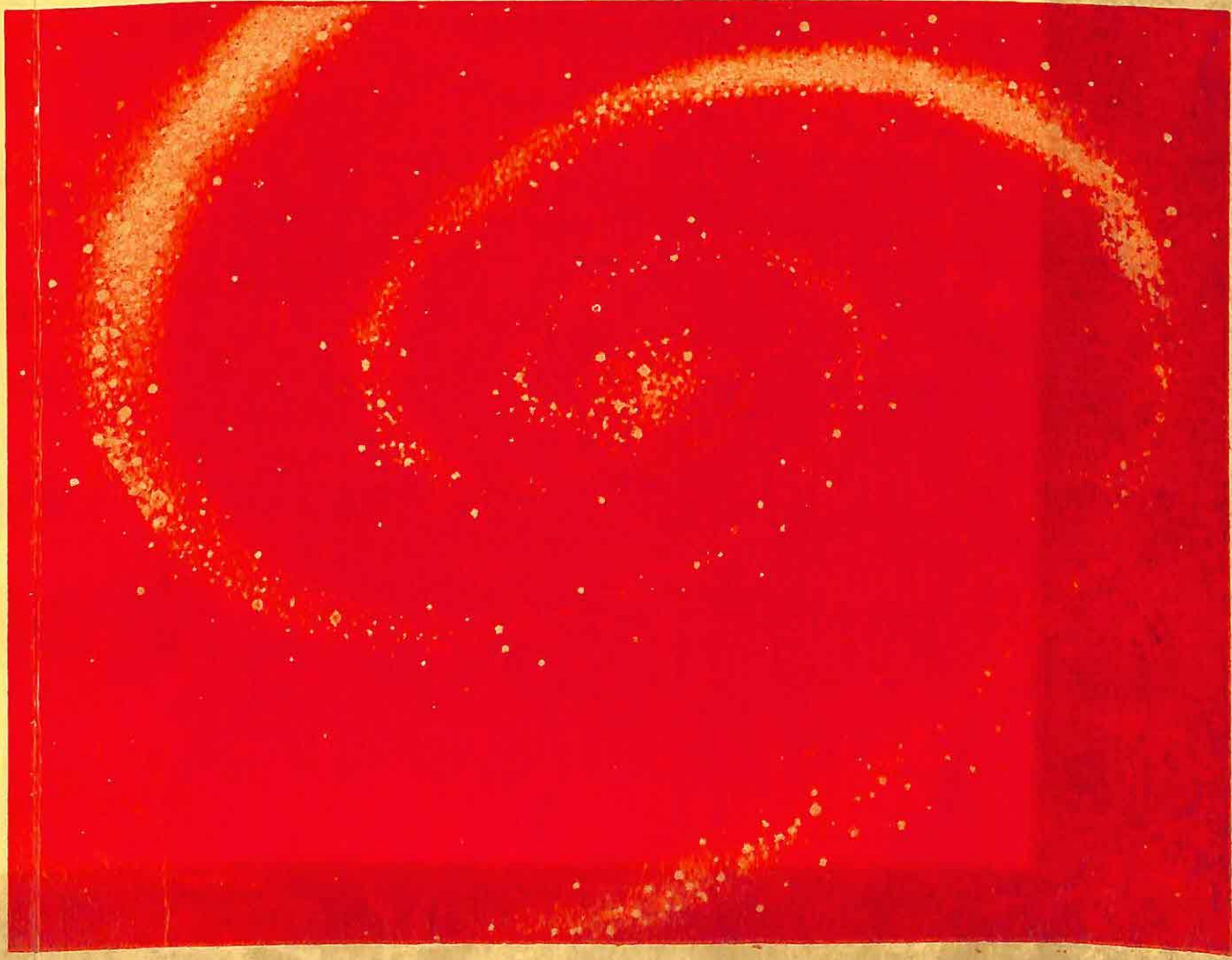
Middle School Science

SCIENCE

Class 6

K. K. Katyal • I.B.Kakar • B. G. Pitre



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Class 6

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Preface

This book is the first of a series of four books, presenting a complete course in Science for students of Classes 6, 7 and 8.

The empirical approach is followed. Simple innovative experiments using easily available apparatus have been used to form concepts based on observations and interpretation of experiments.

The students approach the study of the subject through experiments designed to awaken the spirit of investigation. Care has been taken to present the subject in simple language and to relate the study of Science to the world around us. The contents have been carefully chosen and concepts developed gradually, taking into consideration the level of understanding of the students, so that their interest is sustained.

A salient feature of the series is the 2-4 pages of workbook portion at the end of each chapter, which will help the students test their understanding and to recapitulate the important concepts introduced in the chapter.

November 1984

K K KATYAL
I B KAKAR
B G PITRE

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1

The Earth

The Earth on which we live has all the factors necessary for life. The Earth has an atmosphere containing oxygen; it has water and mineral salts essential for living organisms; it also has a temperature suitable for life activities. Scientists suspect that there are other heavenly bodies in the universe where life exists. However, man has not so far succeeded in locating any.

1.1 Structure of the Earth

Life on the Earth exists on the thin solid sur-

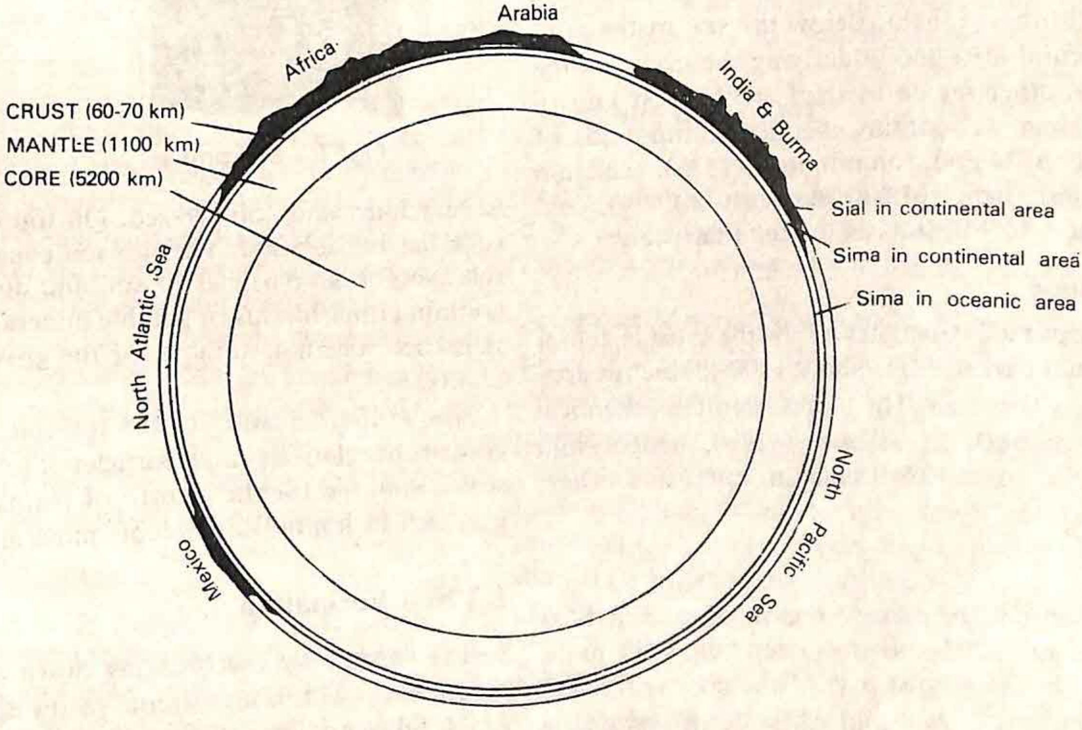


Fig. 1.1 The structure of the Earth

face only. This surface in no thicker in relation to the Earth than the thin shell of an egg.

The Earth is made up of rocks and metals and consists of several shells, like those of an onion. Each shell has its own physical properties and chemical composition. These shells are grouped into three main regions: the outermost is called the **crust.** This surrounds the **mantle.** The innermost region is the **core** (Fig. 1.1).

Crust

About 71% of the Earth's crust is covered by water in the form of oceans, lakes, rivers, etc. and is called the **oceanic area**. The remaining 29% of the Earth's crust is in the form of land masses and is called the **continental area.** The maximum thickness of the Earth's crust is 60-70 kilometres in the continental area, while it is less than 10 kilometres in the oceanic area.

The upper crust on the continental area, on which we live, is known as the **sial**. It contains chemical compounds of several elements such as silicon (69%), aluminium (14%), iron (4%) and others (13%). Below the sial of the continental area and underlying the oceanic area is another region of the Earth's crust known as **sima**. It contains chemical compounds of silicon (48%), aluminium (15%), calcium (11%), iron (11%), magnesium (9%), and others (6%). Sima is denser than sial.

Mantle

The mantle which lies below the crust is denser than the crust. It is about 1100 kilometres deep below the crust. The mantle contains chemical compounds of silicon (43%), magnesium (37%), iron (12%), calcium (3%) and others (5%).

Core

The core is the densest region of the Earth. It is about 5200 kilometres deep below the mantle. The outermost part of the core lying next to the mantle is liquid while the innermost is solid. The core contains 90% iron compounds, 8% nickel compounds and 2% others.

Soil Profile

At the lowest level of the Earth's crust is the parent rock or bed rock (Fig. 1.2). This rock is very hard and compressed. On top of this rock lies the sub-soil. The sub-soil consists of relatively large particles of soil and does not contain either humus or soluble mineral salts. It is therefore not suitable for the growth of plants.

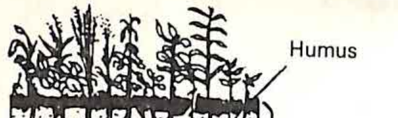


Fig. 1.2 Soil profile

Above the sub-soil lies the top-soil which consists of relatively small particles of soil. Top soil is suitable for the growth of plants since it is rich in humus and soluble mineral salts.

1.2 Soil Formation

Soil is formed by the breaking down of the parent rock. This is an extremely slow process which takes millions of years and is known as

weathering. Some of the ways by which weathering takes place are as follows.

By Wind

You must have seen big rocks in the mountains. When winds blow with high speed, some of these rocks roll down the slopes of the mountains. While rolling down they hit against one another and break down into smaller pieces. They also disturb other rocks lying along their descent and cause them to roll down and break down into still smaller pieces. As this process of rolling down continues, the rocks continue breaking down into smaller and smaller pieces.

The strong winds also carry small rock particles and sand grains with them. The rough surfaces of these particles chip off the surfaces of other rocks in the same manner in which a sand paper chips off a surface against which it is rubbed.

By Water

Movement of water, in liquid form as well as in the form of glaciers, also helps to roll down small pieces of rock. During this rolling down process, the rocks are broken down into smaller and smaller pieces in the same manner in which the winds weather the rocks. While being carried away by the speeding waters or by glaciers, the rough surfaces of the sand grains and small rock particles chip off more soil particles from the rocks along their course. These soil particles form beds along the banks of rivers.

While being rolled down the slopes by wind or water, the rough edges of small pieces of rock become smoothened gradually and these become pebbles.

Force of sea currents dashing against rocks also scrapes them off to form sand particles.

By Chemical Action

Carbon dioxide dissolved in water forms a weak acid called **carbonic acid**. This weak acid reacts slowly against rock surfaces and gradually scrapes them off to form sand particles.

By Heat

Due to the heat of the Sun, the surface layers of rocks expand more than the layers deeper down. This causes the rock surfaces to break down just as a cold container of glass cracks when hot water is poured into it.

By Freezing

Rain water often gets trapped into small cracks and crevices in rocks. In cold regions this water freezes and expands slightly. This expansion produces a sideways pressure which causes the cracks and crevices to become wider. More and more water gets trapped in these widened cracks and crevices, and the pressure finally breaks up the rocks.

By Living Organisms

Roots of plants grow into narrow cracks and crevices in rocks and the force of these growing roots causes the rocks to break down into smaller pieces.

Burrowing animals such as rabbits, moles and earthworms also help to break down bigger soil particles into smaller ones.

1.3 Contents of Soil

Soil is a very complex mixture of several nonliving substances and living organisms. The important constituents of soil are as follows.

Inorganic Materials and Soluble Mineral Salts

These are formed from the rocks which are slowly and constantly being weathered and broken down. A given sample of soil always contains inorganic soil particles of different sizes—varying in diameter from less than 0.002 mm to about 2 mm. According to their size, the soil particles can be classified into four types (Table 1.1).

Humus

It is a dark brown non-living matter which con-

Table 1.1. Classification of soil particles

Size of soil particles (diameter in mm)	*Classification of soil particles*
less than 0.002	Clay
0.002 to 0.02	Silt
0.02 to 0.2	Fine sand
0.2 to 2	Coarse sand

sists of the decaying wastes of living organisms and also the decaying remains of dead animals and plants (specially plants). The decay is brought about by small living beings known as bacteria and fungi living in the soil.

Humus is found mostly in the top-soil as the wastes and dead remains of animals and plants fall and collect in the top-soil. Humus is always rich in soluble mineral salts which are very important for the healthy growth of plants.

Air

Except in water-logged soils, air is always present in the spaces between the soil particles. Since sand particles are loosely packed together there is more air in a given volume of sand than in the same volume of clay. Air in the soil is used for respiration by roots of plants and by the organisms living in the soil.

Water

It is a very important constitutent of soil and is present in the spaces between particles of soil and on the particles themselves. The soil water contains dissolved air and mineral salts such as those mentioned earlier. Plant roots absorb the dilute solution and thus obtain both water and mineral salts.

Soil Organisms

A variety of small and large organisms live in the soil, controlling its texture and fertility. Bacteria are present in large numbers, upto a few million per gram of soil. Bacteria and fungi living in the soil cause the decay of animal waste and dead organisms. Their activities enrich the soil in humus.

Earthworms make the soil porous by burrowing through it, enrich it in nitrogen-containing compounds and make it more fertile. Rats, moles, ants, rabbits, snakes, etc. also burrow into the soil and help to make it more porous and fertile.

Experiment 1. To analyse a sample of soil for its contents. Place a handful of soil in a half-litre measuring cylinder, about three-fourths full of water. Stir the soil thoroughly in this water and leave the mixture undisturbed to settle down for at least 24 hours. You will notice that the heaviest and the largest particles set-

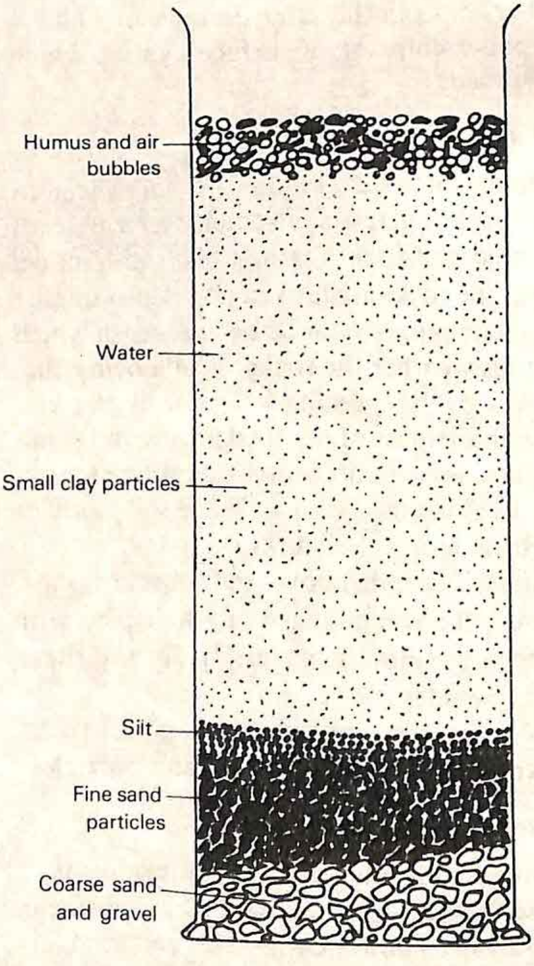
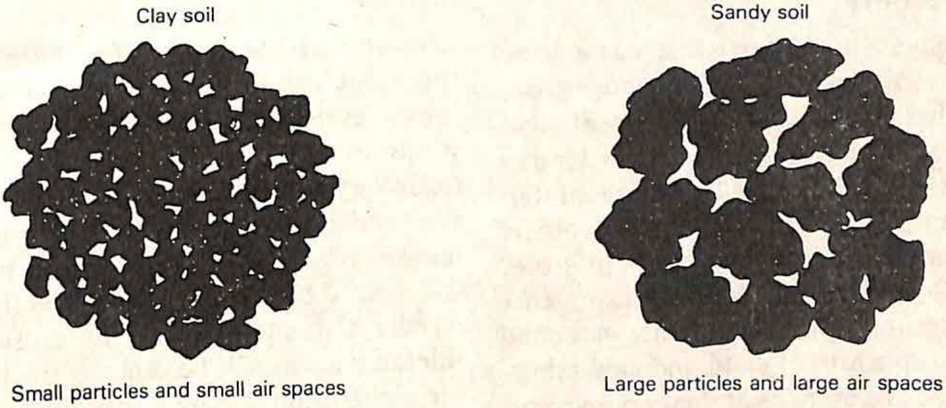


Fig. 1.3 Contents of soil

tle down at the bottom and then the smaller ones in order of size. The top layer will consist of the lightest and the smallest particles. You will also notice some dark coloured humus floating on the surface of the water (Fig. 1.3).


Clay soil

Small particles and small air spaces

Sandy soil

Large particles and large air spaces

Fig. 1.4 Types of soils

1.4 Types of Soils

Many different types of soils are found in our country and in the world. These different types arise from the different proportions in which the constituents are combined in them. The three main types of soils are as follows.

Clay Soil

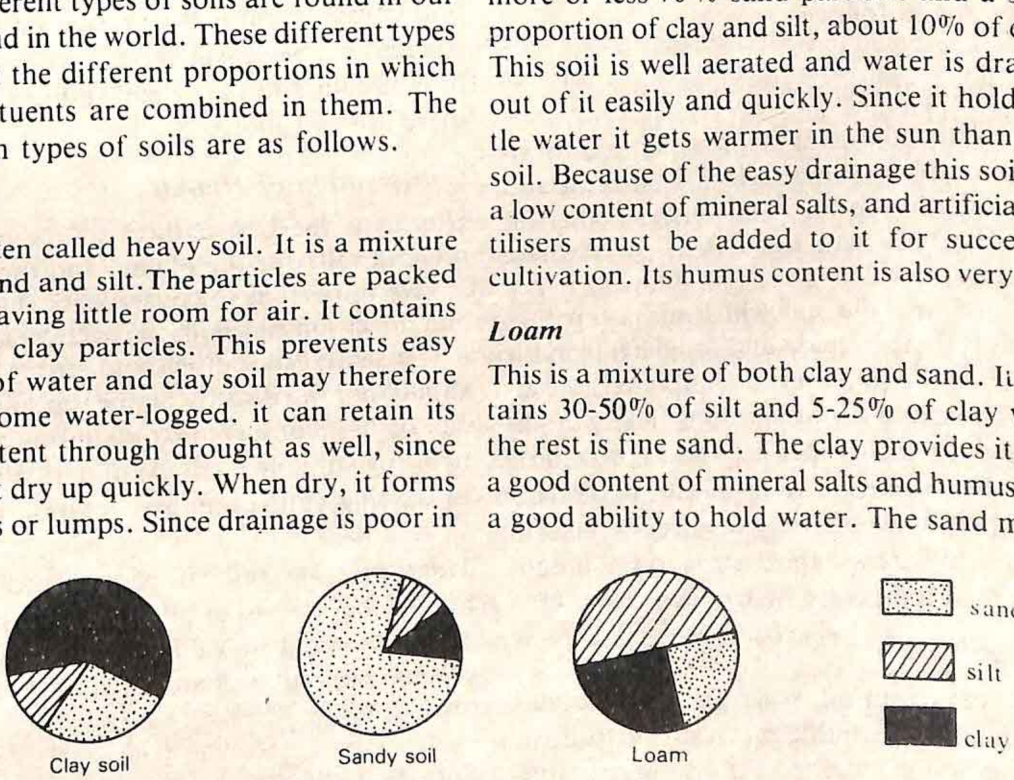
This is often called heavy soil. It is a mixture of clay, sand and silt. The particles are packed closely, leaving little room for air. It contains over 50% clay particles. This prevents easy drainage of water and clay soil may therefore easily become water-logged. it can retain its water content through drought as well, since it does not dry up quickly. When dry, it forms hard clods or lumps. Since drainage is poor in clay soil, it retains dissolved mineral salts and is rich in them.

Sandy Soil

This is often called light soil. It mainly contains sand particles, which are loosely packed and have large spaces between them. It contains more or less 70% sand particles and a small proportion of clay and silt, about 10% of each. This soil is well aerated and water is drained out of it easily and quickly. Since it holds little water it gets warmer in the sun than clay soil. Because of the easy drainage this soil has a low content of mineral salts, and artificial fertilisers must be added to it for successful cultivation. Its humus content is also very low.

Loam

This is a mixture of both clay and sand. It contains 30-50% of silt and 5-25% of clay while the rest is fine sand. The clay provides it with a good content of mineral salts and humus, and a good ability to hold water. The sand makes



Clay soil

Sandy soil

Loam

Fig. 1.5 Composition of soils

it light and easy to work with, provides aeration, and prevents water-logging. Thus loam is better for agriculture than either pure clay or pure sandy soil.

1.5 Soil Fertility

You must have noticed that while plants growing in some soil are very healthy those growing in another soil either do not grow at all or the growth is not healthy. The former kind of soil is a **fertile soil** while the latter one is **infertile**. What makes a soil better than the other? Why are some soils fertile and others infertile?

The fertility of a soil depends on the presence of humus, soluble mineral salts, air, water and a suitable proportion of sand and clay. Shortage or loss of one or more of these components of soil will make the soil infertile. Sometimes even the excess of one or more of these, specially humus and soluble mineral salts, also makes the soil unfit for the growth of plants.

Some of the ways in which soils lose their fertility are as follows.

Destruction of Humus

You have already learnt that the humus is formed in the soil by the activity of bacteria and fungi living in the soil. Obviously, if the soil has no bacteria and fungi in it, or if these organisms are killed in the soil, humus will not be formed and the soil will lose its fertility. What kills these bacteria and fungi living in the soil? When the soil is left uncultivated, the effect of direct and strong sunshine falling on the soil raises the soil temperature and the bacteria and fungi are killed. This also leads to destruction of humus which may be already present in the soil. Where will the destruction of humus be more, in temperate or tropical climate?

Leaching

Due to heavy rainfall, when the water stands in the fields, the soluble mineral salts present in the top-soil get washed off into deeper subsoil. This is known as **leaching.** Ploughing can bring back some of the soluble mineral salts from sub-soil to the top-soil and make it fertile again.

Erosion

Erosion is the washing off or blowing off of the fertile top soil from higher land levels to lower levels due to heavy rains and strong winds. Plant roots and humus bind the soil particles very firmly between them and thus prevent soil erosion by water and wind. When natural vegetation covers the soil, heavy rain is deflected by the leaves and thus falls lightly on the soil and prevents its erosion. Considerable harm will be done to the soil in the form of erosion if there is over-grazing of grass lands by cattle or if trees are destroyed by cutting them down or by forest fires.

1.6 Soil Conservation

Soil conservation is the prevention of loss of soil fertility. Several methods have been evolved to maintain and renew soil fertility. Some of these are as follows.

Conservation of Humus

Humus is the best natural source of soluble mineral salts for the plants, and therefore, it is very important to conserve it. Since strong and direct sunshine kills the bacteria and fungi, it is essential that direct and strong sunshine should not fall directly on the top soil. Humus can be best conserved by manuring as well as by using suitable methods of agriculture such as shifting cultivation and rotation of crops.

Manuring: The soil can be manured by addition of the remains of plants, or the droppings of animals or chemical fertilizers such as urea, calcium superphosphate, calcium ammonium nitrate, etc.

Shifting cultivation: This method is possible only where sufficient land is available for cultivation. After cultivating a land for one or two years, it is not used for the next one or two years. During this period, called the **fallow period,** this land is allowed to become bushy and weedy. This enables the soil to become rich in humus and it becomes fertile again. In the mean time, fresh land is used for cultivation. After one or two years, the original land is used for cultivation once again.

However, the land should not be left bare and exposed to direct and strong sunshine. Some pod bearing cover crop can be cultivated in the land during the fallow period. Pod bearing crop always makes the soil rich in soluble mineral salts. A mulch is also useful for the conservation of humus. This consists in covering the land with some material such as grass cuttings and straw. This allows moisture to be retained in the top-soil and checks its evaporation.

Rotation of crops: Where land is not plentiful, shifting cultivation cannot be practised and the same land has to be farmed from year to year. Since different plants have different requirements of mineral salts, it is useful not to grow the same crop in a particular field year after year. The method of rotation of crops consists of changing the crop in a field from year to year. The mineral requirement of wheat crop is greater than that of certain other cereals. Therefore, cultivation of wheat crop can be followed by other cereals. Root crops also have a lower mineral requirement and as such these can also follow a cereal crop. Since different layers of soil have different quantities of mineral salts, long rooted plants can be cultivated after short rooted plants so that soluble mineral salts from different soil levels may be used.

Cultivating pod bearing plants in between two cereal crops is extremely useful because these plants always make the soil rich in mineral salts. After harvesting the pod bearing crop, if the remains of this crop are ploughed into the soil and allowed to decay, the soil becomes very fertile.

Conservation of Soil Water

During the dry period, it is very important to prevent loss of soil water by **hoeing.** This loosens the soil and allows air into it. It also prevents further rise of sub-soil water to the exposed dry surface. Do you think hoeing promotes activities of bacteria and fungi also and helps in increasing soil fertility?

Prevention of Erosion

Some of the ways which are useful to prevent erosion are as follows.

Planting of shelter belts: Rows of trees are often planted across a flat region where erosion is likely to take place. The trees break the speed of wind and therefore prevent the soil from being blown off by winds.

Contour ploughing and terracing: On the slopes in the hills, the soil is easily washed away by the speeding water and cultivation becomes very difficult. If the furrows in which the crops are planted are made by ploughing along the contours, i.e. across the slope, the speed of the water is reduced and soil erosion is prevented. This can also be done by terracing, i.e. ploughing across the slope and making steps or terraces on which the crops are grown.

Bunding: This method consists of planting weeds in lines across the slope. These serve as brakes so that the speeding water collects on them and its speed is reduced.

Vegetative protection and shade: It involves keeping the soil covered during the rainy period of the year, by planting a cover crop between two crops. Sweet potato and pod bearing plants are very useful for this purpose. The cover crop

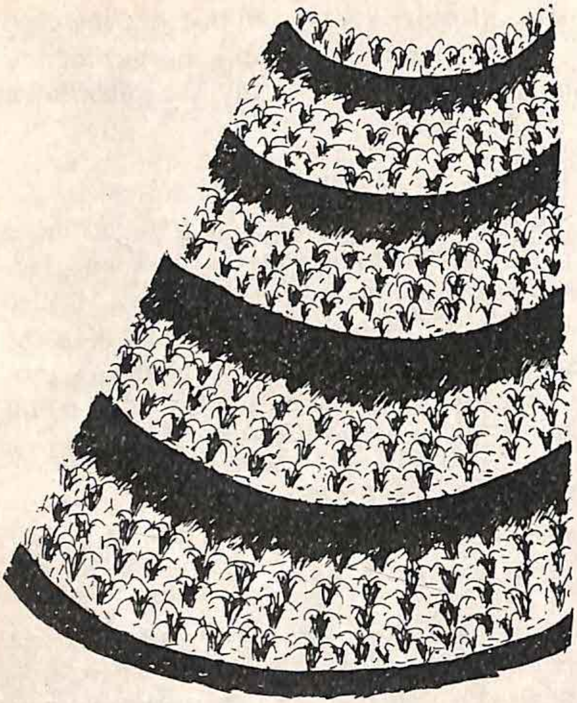


Fig. 1.6 Terracing to prevent soil erosion in hilly areas

also helps to prevent destruction of humus by the heat of the sun.

Prevention against over grazing: Cattle, particularly sheep and goats, graze the grass lands very closely and leave very little plant cover on the soil. The soils thus get exposed to direct heat of the sun and to strong winds. Further, the hooves of grazing animals trample and make the soil into a hard layer. As a result of these activities, there is poor absorption of rain water; the soil dries up quickly and may also be blown away. Over grazing must therefore be prevented.

Use of chemical fertilizers: Addition of chemical fertilizers to the soil leads to better growth and higher yield. However, these chemical fertilizers cannot replace humus, which alone can bind the soil particles together and prevent erosion.

1.7 Minerals from the Earth

You have already learnt that almost the entire Earth is made of rocks which are big store houses of valuable minerals.

Any substance found in the Earth's crust, which is neither an animal nor a plant is a **mineral**. Minerals are made up of chemical substances found within the Earth. Every mineral contains one or more elements.

Minerals and materials made from them occur all around us. Sand and water are very common minerals which you find almost everywhere. The glass in the windowpane, the part of your pencil which holds the tiny rubber in it, the paint on your pencil, the kitchen pans and pots, etc. are all made from minerals. Every day we use so many articles made from minerals. But many of them do not look like minerals because they have been modified by man. For example, glass is made from sand, but does not look like it at all.

There are two types of minerals, which are found within the Earth.

(i) *Metaliferrous minerals:* These include minerals from which metals such as gold, silver, iron, zinc, copper, lead, tin, uranium, platinum, etc. are separated.

(ii) *Non-metaliferrous minerals*: These include minerals such as gypsum, limestone, marble, granite, asbestos, diamonds, precious stones, etc.

There are over 1000 different kinds of minerals in the Earth, but most of these are very rare. From these minerals the required metal or non-metal can be obtained. Some metals or non-metals such as gold and sulphur, sometimes occur by themselves. They are said to occur in their **native** state. The required metal or non-metal is usually present in rocks along with several other impurities. If the quantity of the required substance in the rock is sufficient, the rock is known as the **ore** of the substance. The ore is **mined** and the required metal is separated from it. Thus iron ore may have a mineral containing iron, known as **magnetite**. The ore is dug out and magnetite is separated from it. The metal iron is then **extracted** from magnetite by chemical processes.

Some of the common minerals and the valuable metals and non-metals they contain are as given in Table 1.2.

Table 1.2 Common minerals

Mineral	*Metal or non-metal obtained from it*
Tinstone	Tin
Bauxite	Aluminium
Gypsum	Calcium (plaster of Paris is made from gypsum)
Graphite	Carbon (graphite is used as 'lead' in pencils)
Magnetite	Iron
Hematite	Iron
Malachite	Copper
Copper pyrite	Copper
Magnesite	Magnesium
Talc	(used as base for talcum powder)

EXERCISES

1. Name the factors essential for life. ____________________

____

____

____

2. Name the main groups of concentric shells which make up the Earth. __________

____

3. How do the following differ from one another.

(a) Sial and sima ____________________________

____

____

(b) Continental and oceanic areas ____________________

____

____

(c) Top-soil and sub-soil ________________________

4. (i) What is weathering?

(ii) Mention four important ways in which weathering takes place.

5. (i) What is humus?

(ii) How is it useful to the farmer?

6. How are earthworms useful to the farmer?

7. (a) What soil particles do the following contain?

(i) Clay soil

(ii) Sandy soil

(iii) Loam

(b) Which soil is considered best for agriculture. Why?

8. What are the factors on which fertility of soil depends?

9. Explain the following.

(i) Leaching

(ii) Erosion

10. Why should soil not be left uncultivated for a long time?

11. (i) What is soil conservation?

(ii) Name three important methods of soil conservation.

12. How are pod bearing plants useful in maintaining fertility of soil?

13. What is rotation of crops? Explain with an example.

14. Why cannot chemical fertilizers replace humus, although both supply the plants with soluble mineral salts?

15. Explain how the following are used to check soil erosion.

(i) Terracing ________

(ii) Bunding ________

16. (i) What is a mineral? ________

(ii) What are the two types of minerals? ________

17. What is an ore? ________

18. Name any five minerals and the metals/non-metals they contain. ________

19. Fill in the blanks.

(i) About ________ % of the Earth's crust is covered by water.

(ii) Compounds of ________ are most abundant in the Earth's crust.

(iii) The decay of dead animals and plants is brought about by ________ and ________ .

(iv) Air in the soil is used for ________ by ________ of plants.

(v) Over grazing of grass lands by cattle can lead to____.

(vi) During the dry season________________________of soil is necessary to prevent loss of soil water.

(vii) Bauxite is an ore of________________________.

(viii) Magnetite is an ore of________________________.

20. Write true or false.

(i) The core of the Earth contains mostly compounds of iron.

(ii) The soil particles in clay are larger than in sand.

(iii) Sandy soil can easily become water-logged.

(iv) Plant roots bind soil particles and prevent erosion.

(v) In the fallow period the land is left bare for one or two years.

(vi) Contour ploughing prevents erosion by checking the speed of water flow.

(vii) Gold is never found in its native state in nature.

2

Gravity and Solar System

2.1 Gravitational Pull

Lift a book or any other object to a height and release it. It falls down to the ground. It does not move sideways and does not go up. It simply falls down, showing thereby that something is pulling it down. Newton was the first person who explained why things fall down when they are released from a height. He explained it as follows.

(i) In this universe any two objects attract each other. In this case the Earth attracts the object down and the object attracts the Earth up.

(ii) The force of attraction is more if the mass of the object is greater. We feel this force if we hold anything in our hand or lift anything from the ground. *The force with which the Earth pulls objects towards itself is called the* **force of gravity.** The force of gravity on a body is equal to the weight of

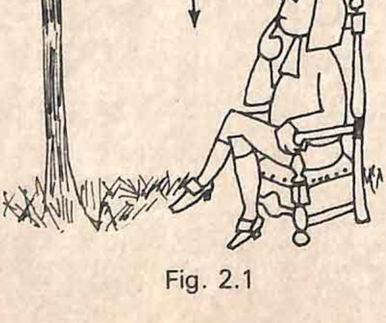


Fig. 2.1

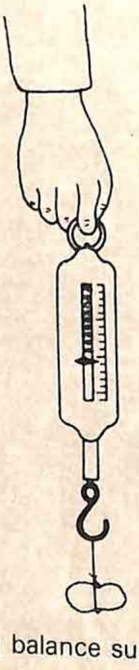


Fig. 2.2 A spring balance supporting an object

the body which we can find with a spring balance.

(iii) The force of attraction decreases as the distance between the two objects increases. Thus the force of gravity gets smaller as things get further away from the Earth. A person in an aeroplane would therefore weigh less than what he would weigh on the ground.

As a spacecraft goes further from the Earth towards the Moon, its weight decreases. At a large distance from the Earth the weight is almost zero and an astronaut would experience 'zero gravity' and can float around in space. As his spacecraft approaches the Moon, it experiences the gravitational effect of the Moon. The gravity on the surface of the Moon is less than the gravity on the Earth as the Moon is much smaller than the Earth. The gravity of the Moon is one-sixth that of the Earth. Hence, a man who weighs 90 kilogram-weight on the Earth would weigh only 15 kilogram-weight on the Moon. He would be able to throw things much further and jump much higher because the force pulling him down would be smaller.

2.2 Mass and Weight

The weight of things depends not only on the gravitational pull but also on what material they are made up of. If you hold a cricket ball in one hand and an apple of the same size in the other hand, you would feel that the cricket ball weighs more than the apple. This is because the stuff (the matter) of which cricket balls are made is more tightly packed than the matter of which apples are made.

The total amount of matter in any object is called its **mass.** It is measured with a beam balance. The unit in which mass is measured is called the **kilogram.** On the other hand **weight** *is the force with which the Earth pulls down a body.* It is measured with a spring balance. The unit in which weight is measured is the **newton** or **kilogram-weight.** The weight of a body of mass 1 kilogram is 1 kilogram-weight on the surface of the Earth. On the Moon, its mass will remain 1 kilogram since the amount of matter in it does not change. However its weight will only be one-sixth of a kilogram-weight as the force with which the Moon pulls down the body is one-sixth of that on the Earth. Thus the mass of a body always remains the same but the weight changes with the gravitational force.

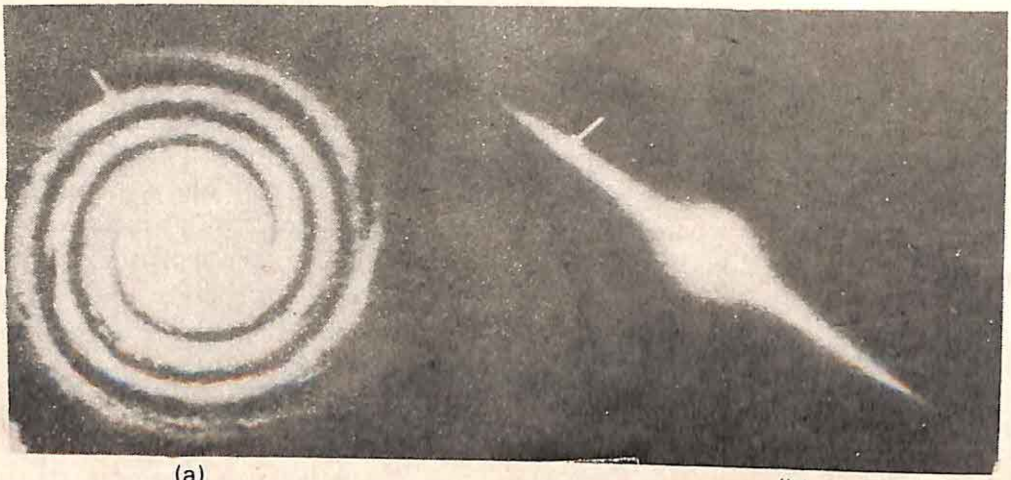
2.3 The Universe

Men have gazed in wonder at the heavens from the very earliest times. They worshipped the Sun, Moon and planets as gods. We have a Sun temple in Konark and a temple of all the planets (*grahs*) in Jagannath Puri in Orissa. As man learnt about the movements of heavenly objects, he used them to measure time and to form the basis of calenders.

On a clear moonless night we see a large number of tiny dots of light hanging in the sky. Most of them twinkle. If we observe them over several nights we find that though they appear to move from east to west, their position with respect to other bodies seems to remain fixed. Such heavenly bodies are called **stars.** They give out their own light. You can also see other heavenly bodies in the sky which do not twinkle. They appear to move, not only with respect to the Earth, but also with respect to the stars. These are known as **planets.** They do not produce their own light and only reflect the light of the Sun that falls on them.

With the naked eye you can see in the sky about 6000 stars on a clear moonless night. If you use a small telescope you can see 100,000 stars. Nearly twenty thousand million stars are visible through the most powerful telescope in the world.

Several million stars form a group known as a **galaxy.** All the stars we see with a powerful



(a)

(b)

Fig 2.3 The Milky Way— The arrows show the position of the solar system

telescope belong to *our* group of stars. This galaxy to which our Sun and Earth belong is known as the **Milky Way** (Fig. 2.3). It is a spiral galaxy, of the shape of a poached egg.

2.4 Measurement of Astronomical Distances

The **Proxima Centure** is the nearest star to our Earth next to the Sun. Do you know how far from the Earth it is? It is at a distance of approximately 41,000,000,000,000 kilometres! You can see that it is very inconvenient to write astronomical distances in kilometres. Scientists therefore measure these distances in another unit known as a **light year.** *One light year is the distance travelled by light in one year.*

Now, speed of light = 300,000 km per sec. Therefore in one year light will travel a distance of 300,000 × 365¼ × 24 × 3600 kilometres which is approximately 9,500,000,000,000 (written as 9.5 & 10^{12}) km.

In this unit the distance of Promixa Centure from the Earth is 4.3 light years.

the diameter of the Milky Way is about 150,000 light years and its thickness is about 20,000 light years.

2.5 The Sun

The Sun is the closest star to the Earth, being about 150 million kilometres away. Light takes about 8 minutes to travel from the Sun to the Earth. it is therefore said to be at a distance of 8 light minutes from the Earth. When we look at the Sun, the sunlight which we receive at any instant had started from the Sun eight minutes earlier. We are therefore looking back in time!

The Sun is a star and compared to some other stars it is rather small and insignificant.

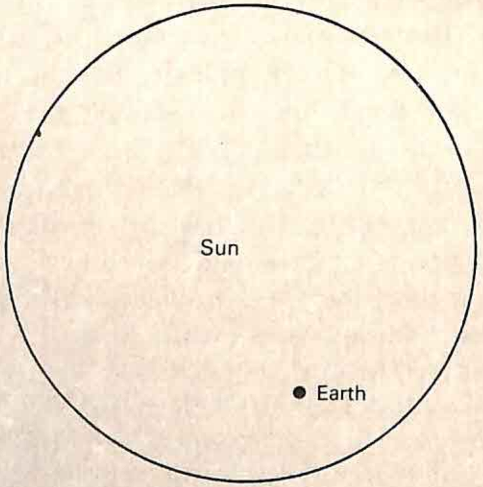


Fig 2.4 Comparitive sizes of Sun and Earth

Compared to our planet, Earth, it is very large. It has a diameter of about 1,392,000 kilometres. This is more than 109 times the diameter of the Earth. It is also 333,000 times as heavy as the Earth. It provides us with heat and light. On the Earth we receive only a small fraction of the total energy emitted by the Sun.

The centre of the Sun is extremely hot and its temperature is 14 million °C. Compare this to the temperature of the Earth's surface which hardly ever rises above 50°C!

2.6 The Solar System

The solar system consists of a large family of heavenly objects which move round the Sun. Its largest and most important members are the planets. Nine planets are known to us. The Earth on which we live is one of them. They move round the Sun in nearly circular paths called **orbits.** There are also other smaller objects which move round the Sun. These are asteroids (minor planets) and comets. *The whole group of planets, asteroids, and comets which move along with the Sun is called the* **solar system.**

Kepler (1571-1630) showed that planets move round the Sun in **elliptical** orbits. To draw an ellipse, loop a long piece of thread round two pins. Pull the thread tight with a pencil and, keeping it tight, move the pencil round the pins.

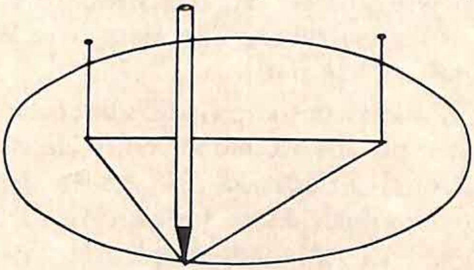


Fig. 2.5 Tracing an ellipse

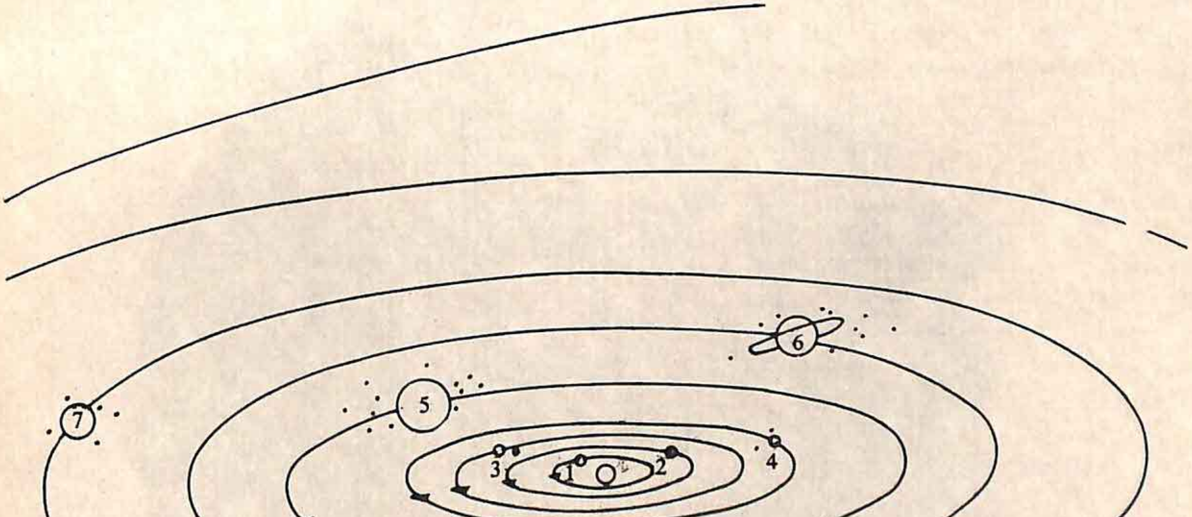


Fig. 2.6 The solar system

The trace thus obtained on the piece of paper is an ellipse (Fig. 2.5). Planets move round the Sun because of the force of gravity between the Sun and planets.

Figure 2.6 shows the nine planets and their orbits around the Sun and also their **diameters**. Table 2.1 gives their **diameters** and distances from the Sun.

2.7 The Moon

Heavenly objects that revolve around a planet are called **satellites.** The moon is a **natural satellite** of the Earth.

Until 1959 our knowledge about the Moon and the planets was based upon what we could see from the Earth. In 1959 the Russians sent a space vehicle **Luna 1** which went past the Moon and sent photographs of its surface which faces the Earth. **Luna III,** also sent in 1959, sent to Earth even the pictures of the hidden side of the Moon.

Table 2.1 The planets; their diameters and distances from the Sun

Planet	*Distance from the Sun (million km)*	*Diameter (km)*
1. Mercury	58	4880
2. Venus	108	12100
3. Earth	150	12756
4. Mars	228	6790
5. Jupiter	778	142800
6. Saturn	1427	120000
7. Uranus	2870	51000
8. Neptune	4497	49000
9. Pluto	5900	3000

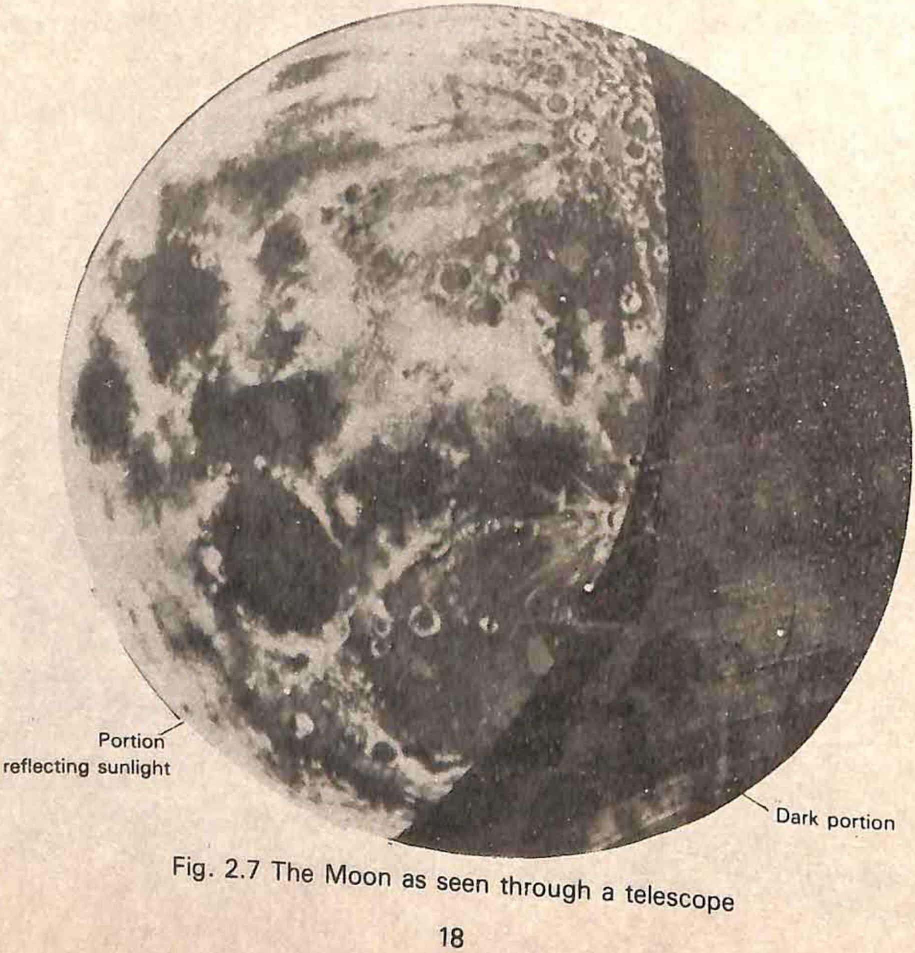


Fig. 2.7 The Moon as seen through a telescope

On 20 July 1969 two American astronauts, Neil Armstrong and Edwin Aldrin, landed on the Moon. The Moon trip has been repeated since then. Astronauts have conducted many experiments on the Moon and have brought back samples of Moon rocks. From the study of these rocks, we can now say that the Moon is as old as the Earth.

The Moon is our nearest neighbour in space. It revolves round the Earth in an orbit at an average distance of 384,000 kilometres. It takes 29 days to complete one revolution and also takes 29 days to complete one rotation round its axis. Hence, the same face of the Moon is always turned towards us.

There is no atmosphere on the Moon. No animals or plants can breathe on the Moon. There is also no water on the Moon and it never rains. In daylight the temperature of the Moon's surface rises above 127°C. After sunset the temperature falls to −153°C.

With the naked eye one can see dark grey patches on the Moon's surface. Galileo was the first person to see the rough surface of the Moon through a telescope. He noticed that the Moon's surface has large craters and high mountains. The craters are ring like formations and resemble volcanic craters on the Earth. Some mountains on the surface of the Moon are even higher than Mt. Everest. Besides, there are vast areas of flat land generally known as **seas.**

The gravity of the Moon is one-sixth of what it is on the Earth. If you weigh 42 kg on the Earth you would weigh only 7 kg on the Moon! You can jump six times as high on the Moon than on the Earth!

Phases of the Moon

The Moon does not give out its own light. It only reflects to the Earth the light of the Sun falling on it. Moonlight is thus reflected sunlight.

You must have noticed that the size of the Moon appears to change every day. One night it is a thin curve. A few nights later it is a half

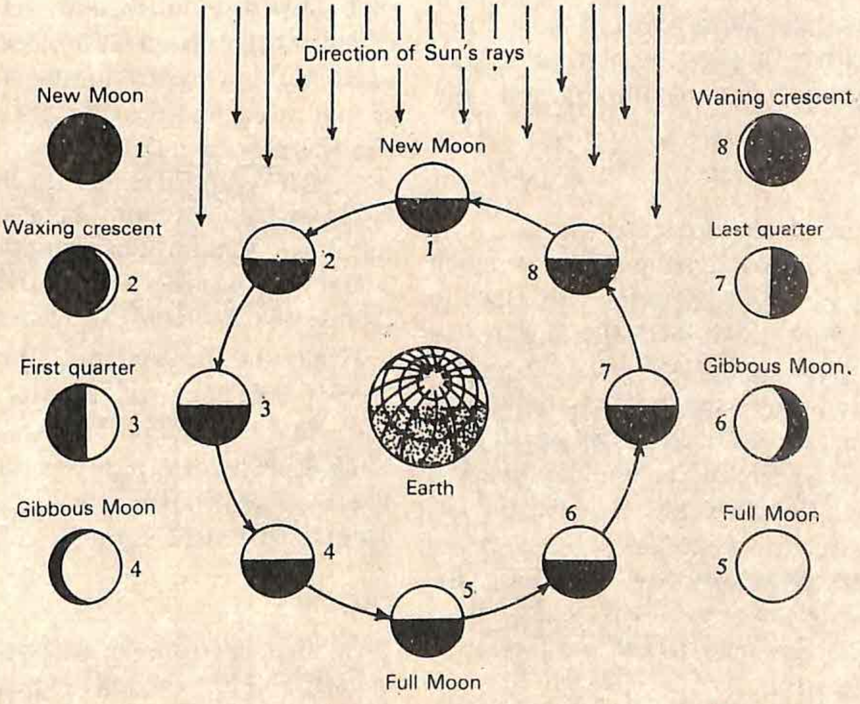


Fig. 2.8 Phases of the Moon

moon and in another week or so it is a complete circle. Then it appears to get smaller until, in about two weeks, it disappears completely.

These changes are called **phases** of the Moon. Of course the size of the Moon does not actually change. What changes is the area of the Moon that is visible to us due to reflected sunlight.

When the Moon lies between the Earth and the Sun, the side of the Moon turned to the Earth does not receive sunlight. It is therefore dark and we cannot see it, as shown in position 1, Fig 2.8. This is the **new moon.** But as it moves in its orbit, it seems to grow and change shape as more and more of its illuminated surface is seen. When it is on the other side of the Earth to the Sun (position 5, Fig. 2.8) we see the **full moon**. Then it gets smaller until it disappears again. The phases repeat themselves every 29 days.

2.8 The Planets

Man has sent spaceships referred to as 'probes' which either fly past the planets or land on them, and send valuable photographs and other data to us.

Mercury

Mercury is the planet closest to the Sun. It is so small that its gravitational pull is not enough to retain any atmosphere. Being very close to the Sun, the side which faces the Sun is very hot and the dark side is very cold. Its year is equal to 88 Earth days and its day is of 59 Earth days. This means that it taken 88 Earth days to complete one revolution round the Sun and 59 Earth days to spin round its axis. Its surface is cut with craters and has mountains and deserts similar to the surface of the Moon. Being very close to the Sun, it is very difficult to observe. It is seen near to the Sun, close to sunset and sunrise.

Mercury has no moons.

Venus

It is visible after sunset and before dawn. Hence it is known as the 'evening' and the 'morning' star. It is about the size of the Earth and is the planet nearest to the Earth. Yet it is very difficult to see as its surface is covered by a thick layer of clouds. The same clouds which prevent us from seeing it reflect back most of the light falling on them. This explains why it is the brightest planet.

Venus takes 225 days to revolve round the Sun and 224 days to complete one rotation about its axis. Space probes have landed on Venus and have found its surface to be very smooth. It is, however, a very hot planet and has an atmosphere consisting mostly of carbon dioxide. The pressure exerted by its atmosphere is 90 times that of the Earth's atmosphere.

Venus, like Mercury, also does not have any moons.

Mars

Mars can be recognized in the sky by the reddish glow it emits. It is therefore commonly called the **red planet**. It has no cloud covering and has a thin layer of atmosphere mainly consisting of carbon dioxide. Its reddish surface can therefore be easily seen.

The duration of a day on Mars is more or less same as that on the Earth (24 hrs 37 minutes). A careful examination of the Mars surface shows it to be colourful; with orange plains, blue highlands and bluish-green craters.

Even now some scientists believe that some form of life does exist on Mars. However, no life was detected by *Viking Lander 2* which landed on the Mars surface in 1976. If at all life exists on Mars it is most likely to be in the form of very simple plants. Mars has 2 moons.

Jupiter

It is the largest planet of the solar system. It is not solid like the Earth but seems to consist mainly of hydrogen gas. The surface is not visi-

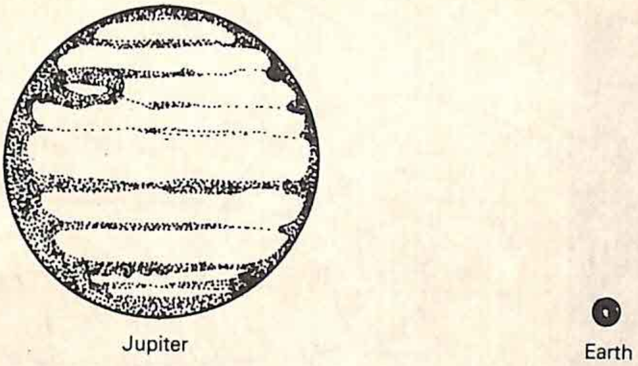


Fig. 2.9 Jupiter with Earth to scale

ble since the planet is covered by belts of clouds. An enormous red spot, almost the same size as the Earth, can be seen in the clouds.

Its day is of 9 hr 50 min duration. It has 16 moons which orbit around it.

Saturn

It is a large planet and is seen in the sky with the naked eye as a bright yellow planet. It is very similar to Jupiter. It also consists mainly of hydrogen. The strangest feature of Saturn is the series of **rings** which encircle it. These are thin flat belts of particles possibly consisting of ice.

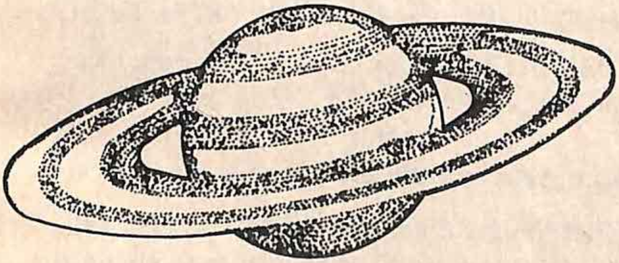


Fig. 2.10 Saturn and its rings

Its year consists of 29½ Earth's years and the day is of 10 hr 14 min. It has 15 moons.

Uranus

It is interesting to know that two mathematicians predicted by calculations the presence of this planet between Saturn and Neptune. Astronomers looking in that part of the sky, ultimately found it in March 1781. Uranus is so far from the Sun that it takes 84 Earth years to complete one revolution round the Sun. It takes 18 hours to once spin round its axis. When seen through a telescope it appears green. It has 5 moons and is a very cold planet.

Neptune and Pluto

These can only be seen through a telescope. Neptune has 2 moons. Its year is equal to 165 Earth years and a day is of 23 hours duration.

Pluto is the most remote member of the solar system. Its presence was predicted in 1931 by calculations. It has 1 moon. Its year is equal to 248 Earth years and a day is equal to approximately 6⅓ Earth days.

2.9 Comets

A comet is a strange member of the solar system and is an occasional visitor. It suddenly appears in the sky and approaches the Sun with great speed. Then it moves away from the Sun and finally disappears from our view. As it approaches the Sun two distinct parts are visible.

(i) A brilliant star-like head surrounded by cloudy matter.
(ii) An elongated luminous tail which points away from the Sun.

As it approaches the Sun it becomes brighter. The tail consists of gaseous matter and

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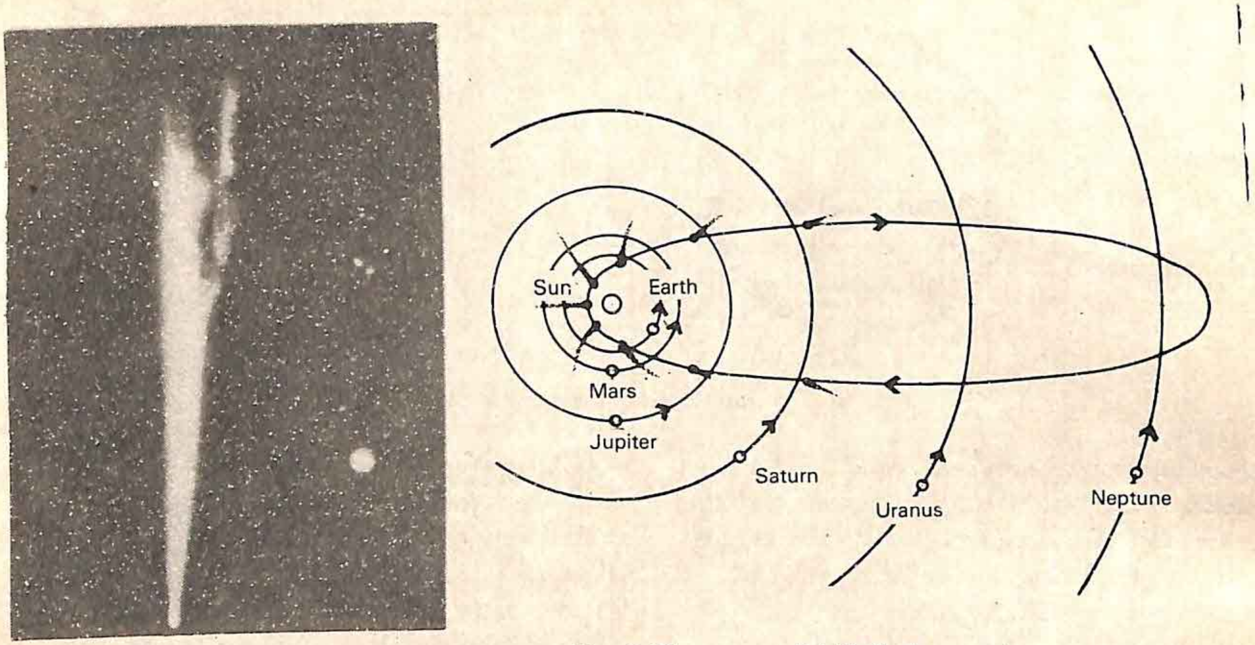


(a) A comet Fig. 2.11 (b) Halley's comet

sometimes stretches over thousands of kilometres in the sky. As a comet recedes from the Sun the tail gradually diminishes and finally disappears.

Some comets appear only once while others are periodic in nature. For example, Halley's comet comes into view every 76 years. It last appeared in 1910 and will now reappear in 1986.

2.10 Meteors and Meteorites

If we look at the sky on a clear night we often find streaks of light moving across the sky, and finally disappearing at a distance. These are popularly known as shooting stars. Actually they are not stars but pieces of matter which travel with a high speed in space. Whenever these bodies come into contact with the Earth's atmosphere, they heat up due to friction with air and in most cases burn to ashes. They are called **meteors**. During the process of heating, they glow up and look like 'shooting' stars. *Thus a meteor is a solid body which enters the Earth's atmosphere and shines brightly because of heat produced by friction with air and gets completely burnt to ashes.*

If a meteor is large and is pulled down to the Earth before being completely burnt, then the remanant part which reaches the Earth's surface is called a **meteorite**. Some of these meteorites can be seen in museums. Thus a *meteorite is a large meteor which is not completely burnt to gas, but falls on the Earth.*

Meteors are mainly composed of iron, nickel and stony matter.

2.11 Artificial Satellites

The Moon is a natural satellite of the Earth. It rotates around the Earth once in about 29 days. However, there are also present in space artificial satellites orbiting the Earth which have been sent up by man. The first such satellite was **Sputnik 1** sent by Russia in 1957. Since then thousands of artificial satellites have been sent up by man. The Indian satellite INSAT IB helps us in predicting the weather, in transmitting television programmes and in establishing telephone links throughout our country.

EXERCISES

1. Fill in the blanks in the following sentences.
   (i) The force with which the Earth pulls a body is called the force of________.
   (ii) The force of gravity increases with the________________of a body and decreases with ________________.
   (iii) Mass is measured in________________with a physical balance and weight is measured with a____________in____________.
   (iv) The Milky Way is a ________________. The Moon is a natural ________________ of the Earth.
   (v) The Sun is ________________light minutes away from the Earth.
   (vi) The temperature of the centre of the Sun is________________°C.

2. Read each of the following sentences carefully. If you think it is true write 'True'. If it is not true, then write down the word or words to replace the one in italics in order to make the sentence true. For example.
   (a) The heavenly body which gives out its own light and remains fixed relative to other heavenly bodies is a *star*. TRUE
   (b) The body which wanders about the sky is a *star*. PLANET
   (i) The planet nearest to the Earth is *Mars*.
   (ii) The planet nearest to the Sun is *Uranus*.
   (iii) The planet with rings is *Venus*.
   (iv) The largest planet of the solar system is *Saturn*.
   (v) The planet farthest from the Sun is *Pluto*.
   (vi) The 'red planet' is *Mars*.
   (vii) The planet which has a red spot on its surface is *Mars*.
   (viii) The planet which appears after sunset or before dawn is *Venus*.
   (ix) The planet which has the maximum number of moons is *Saturn*.
   (x) The brightest planet in our solar system is *Jupiter*.

3. Give two ways in which the mass of a body differs from its weight. ____________

____

____

____

____

4. How can you distinguish a planet from a star while looking at the sky with the naked eye?

____

____

____

5. Match the two lists below. An example is provided.

Name	*Kind of body*
1. Proxima Centure →	(a) Morning star
2. Moon	→ (b) Nearest star next to Sun
3. Saturn	(c) Planet with rings
4. Milky Way	(d) Satellite
5. Venus	(e) Galaxy
6. Meteor	(f) Heavenly body with a tail
7. Comet	(g) Shooting star

6. Differentiate between meteor and meteorite. ______________________

____

____

7. What do you mean by the phases of the Moon? ______________________

____

____

____

8. Name the nine planets in the order of their distances from the Sun.

1. ______________ 2. ______________ 3. ______________
4. ______________ 5. ______________ 6. ______________
7. ______________ 8. ______________ 9. ______________

9. Name two planets which have no moons of their own.

1. ______________________ 2. ______________________

10. Name a periodic comet. When will it appear next? ______________

____

3

Air, Burning and Rusting

Our planet Earth is surrounded by a layer of air called the **atmosphere.** Most of it lies within 16 km of the Earth's surface. The air thins out slowly with height until very little of it is left beyond about 80 km. This marks the beginning of outer space.

3.1 Burning

From very early times man knew how to make fire. Fire kept him warm, cooked his food, helped him to see things in the dark and chased away wild animals when he slept.

Experiment 1. Light a candle and stick it on a piece of cardboard. Place it on a table and invert on it a glass chimney as shown in Fig. 3.1a. You will notice that the candle keeps burning for some time and then the flame goes out.

Now remove the chimney and attach some plasticine to its base (Fig. 3.1b). Light the candle and put the chimney back over it. You will find that now the candle keeps burning. The plasticine raises the chimney and allows the air to enter.

In the first experiment, the air above the flame becomes hot and lighter. It rises above and leaves the chimney from the top. No air can enter from outside and finally the flame goes out. In the second experiment, air enters from below and a constant supply of air is maintained. The candle in this case keeps burning. We may therefore conclude that *air is necessary to keep things burning.*

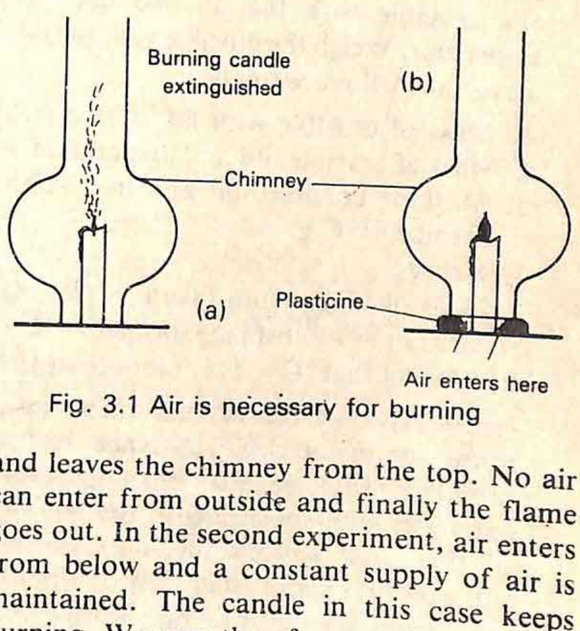


Fig. 3.1 Air is necessary for burning

3.2 Change of Mass during Burning

Experiment 2. Weigh a clean and dry crucible with a lid. Put a 10 cm long folded magnesium ribbon in the crucible, cover it with the lid and weigh again. Remove the lid and heat the crucible strongly. When magnesium begins to burn, cover the crucible with the lid. You will

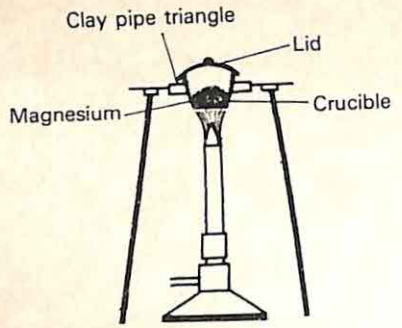


Fig. 3.2 Change of mass during burning

notice that white particles of some substance are formed. Raise the lid slightly so as to allow the air to enter but ensure that the white particles do not go out of the crucible. Cover the crucible with the lid and cool it in a **desiccator.** Weigh the crucible with the lid. You have taken three weights.

1. Mass of crucible with lid = A g (say)
2. Mass of crucible, lid and magnesium = B g
3. Mass of crucible, lid and new substance formed = C g

Hence,

Mass of magnesium taken = $(B-A)$ g

Mass of new substance formed = $(C-A)$ g

It is found that $(C-A)$ is more than $(B-A)$.

This experiment shows that when a substance burns in air, a new substance is formed, probably because the burning substance combines with something in the air. Because of this combination, the mass of the new substances is more than that of the burning substance. What is this new substance? And what is the 'something' in air which combines with magnesium?

3.3 The Discovery of Oxygen

An English scientist Priestley performed his classic experiment in 1774 in which he heated a reddish mineral (known as mercuric oxide) by focussing sun rays on it, using a magnifying glass. A simple form of Priestley's apparatus is shown in Fig. 3.3.

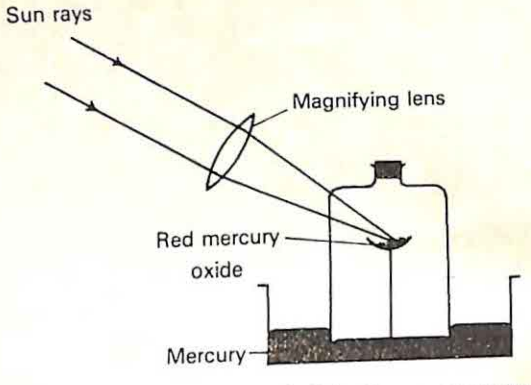


Fig. 3.3 Simple form of Priestley apparatus for preparing oxygen

Priestley collected the gas given off during the experiment. He found that in it a lighted candle burnt more brightly and small creatures were more active than in air.

Priestley told the French scientist Lavoisier of his experiment. Lavoisier then carried out an experiment in which he heated pure mercury in air for twelve days. He noticed a red powder on the surface of the hot mercury. He collected this red powder and then heated it strongly. He obtained mercury and 'Priestley's gas' which caused a glowing splinter to burn brightly and in which small creatures were found to be more active than in air. Lavoisier named this gas oxygen. The changes which took place are as follows:

mercury + oxygen $\xrightarrow{\text{heat}}$ mercury oxide (reddish powder)

mercury oxide $\xrightarrow{\text{strong heat}}$ mercury + oxygen

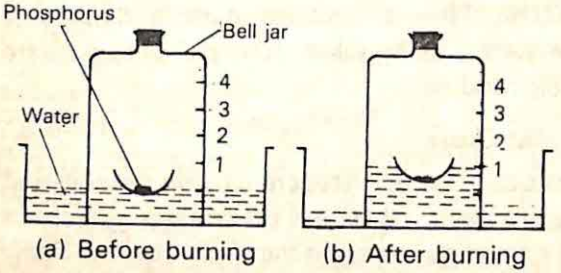
Thus the 'something' in air is the gas oxygen. In Experiment 2, when magnesium burns in air it combines with oxygen to form white particles of magnesium oxide.

magnesium + oxygen → magnesium oxide

3.4 How Much Air is Used up in Burning

Let us now try to find out how much air by volume is used up in burning. To do so we use white phosphorus, a substance which catches fire when kept in air. In the laboratory it is stored in water in a bottle to prevent it from catching fire. White phosphorus is poisonous so you should not touch it with your hands.

Experiment 3. Float an evaporating dish containing white phosphorus in a trough of water and place a bell jar over it. Divide the space above the level of water in the bell jar into five equal parts (Fig. 3.4a). Burn the phosphorus by touching it with a hot iron wire, withdraw the wire and quickly put the stopper on the bell jar. The phosphorus burns with a yellow flame giving off dense white fumes. While the phosphorus is burning, you may notice that the level of water inside the bell jar initially goes down slightly.



(a) Before burning (b) After burning

Fig. 3.4 Oxygen is used up during burning

After some time the burning stops. Note the level of water in the jar at the end of the experiment. The level of the water inside the jar rises to the first mark (Fig. 3.4b). Remove the stopper of the bell jar and quickly introduce a lighted splint into it. The splint is extinguished. Why? The white fumes disappear after some time. What could these white fumes be and where do they disappear?

When phosphorus burns, the heat produced causes expansion of air; hence the level of water falls in the beginning. When the air gradually cools down, the level runs to one-fifth of air present in the jar. Hence one-fifth of the air has been used up in burning. This suggests that air contains one-fifth by volume of gas which supports burning.

When the active part of air is used up in burning, water takes its place. Now when a lighted splint is introduced into the residual air the splint is extinguished; this residual part of air, therefore, does not support burning. Thus, air contains at least two gases. The part of air which supports burning is **oxygen**; the part of air which does not support burning mainly contains a gas known as **nitrogen.**

The white fumes show that a new substance is formed by the combination of phosphorus with oxygen of the air. This is called phosphorus oxide, more correctly phosphorus pentoxide. We write this reaction in the following way:

phosphorus + oxygen → phosphorus pentoxide

The fumes of phosphorus pentoxide disappear by dissolving in water.

3.5 Other Gases Present in Air

Water Vapour

In the upper atmosphere air carries clouds which give us rain. Ponds, wet clothes, etc. are always drying out due to evaporation of water. This suggests that water vapour is always present in the air around us.

Test for water: Prepare a solution of *cobalt chloride* in water. The colour of the solution is pink. Dip a strip of filter paper in the solution and dry the strip by keeping it well over a bunsen flame. Do you notice any change in colour? Put a drop of water on the dry strip of paper. Do you observe any change?

Dry cobalt chloride is blue in colour. When drops of water fall on the cobalt chloride paper, it turns pink. The dry cobalt chloride paper can, therefore, be used for testing the presence of water.

Experiment 4. Place on the table a glass of water with a few pieces of ice in it and cover it with a lid. Within a few minutes you will observe tiny drops of a colourless liquid on the outside of the glass. Where could these drops of colourless liquid have come from?

Touch a dry cobalt chloride paper to the drops of liquid on the outside of the glass. The paper turns from blue to pink showing that the liquid is water. The water was formed by condensation of vapour present in the atmosphere due to the very low temperature outside the glass.

The early morning dew which we see on the ground and on leaves during winter is formed by condensation of water vapour in the air.

Carbon Dioxide

Experiment 5. Take some *lime water* in two bottles fitted with rubber stoppers. These are fitted to an apparatus shown in Fig. 3.5, so that if you suck in through the tube T, the air enters through bottle 1; and when you breathe out, the air goes out through bottle 2. Now suck in and out a few times. Both the bottles with lime water in them are kept side by side for comparison. Do you notice any difference in the two samples?

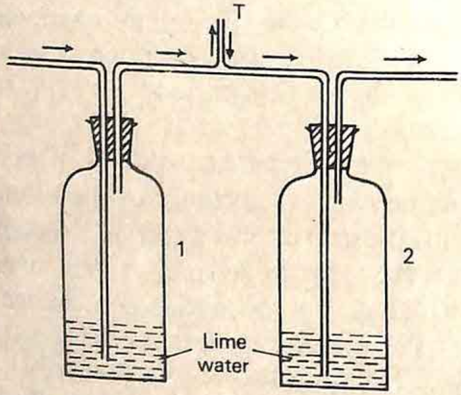


Fig. 3.5 Exhaled air contains carbon dioxide

You will observe that the lime water through which the exhaled air is passed forms a milky suspension. This is due to a gas called **carbon dioxide.**

Actually, some carbon dioxide is also present in the air we inhale. However, it is present in such a small quantity that the lime water in bottle 1 will become milky only when air is sucked in through it for almost half an hour.

Carbon dioxide gas is also produced when fuels such as coal, coke, wood, petrol, etc. burn in air. All fuels contain the element carbon which on burning gives carbon dioxide.

carbon + oxygen → carbon dioxide

Thus enormous amount of carbon dioxide is being added to the atmosphere during burning and breathing. In spite of this, however, the proportion by volume of carbon dioxide in the air remains constant at about 0.03%. This is because carbon dioxide is constantly being taken in by plants to prepare their food.

Noble Gases

Besides oxygen, nitrogen, carbon dioxide and water vapour, there are other gases present in very small quantities in the air around us. These are helium, neon, argon, krypton and xenon. These gases are generally very inactive, i.e. they hardly react with other chemicals. Hence, they are called **inert** or **noble** gases.

3.6 Composition of Air

Careful measurements show that the approximate composition of air, by volume, is as follows.

Nitrogen	—	78.1%
Oxygen	—	20.9%
Carbon dioxide	—	0.03%
Noble gases	—	0.95%
Water vapour and other gases	—	in small traces

The composition of the gases in air is generally constant everywhere in the Earth's

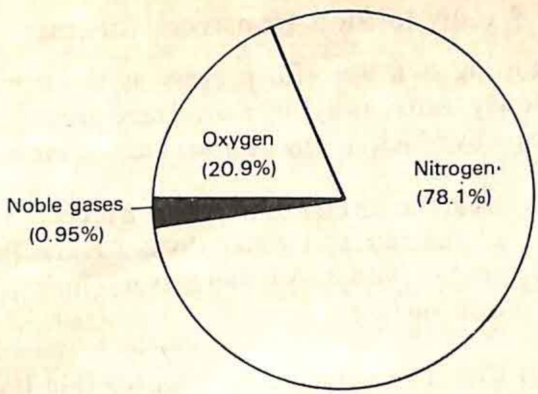


Fig. 3.6 Composition of air

atmosphere. However, the content of water vapour varies considerably from place to place.

Nitrogen is the most abundant of all gases. It is quite unreactive and does not easily react with other chemicals. One advantage of nitrogen is obvious; if air were to contain mostly oxygen, even small fires would turn into huge explosions and cause great damage. The large proportion of an inactive gas like nitrogen therefore keeps fires under control. Nitrogen is needed by all living things. Carbon dioxide is required by plants to prepare their food.

3.7 Rusting

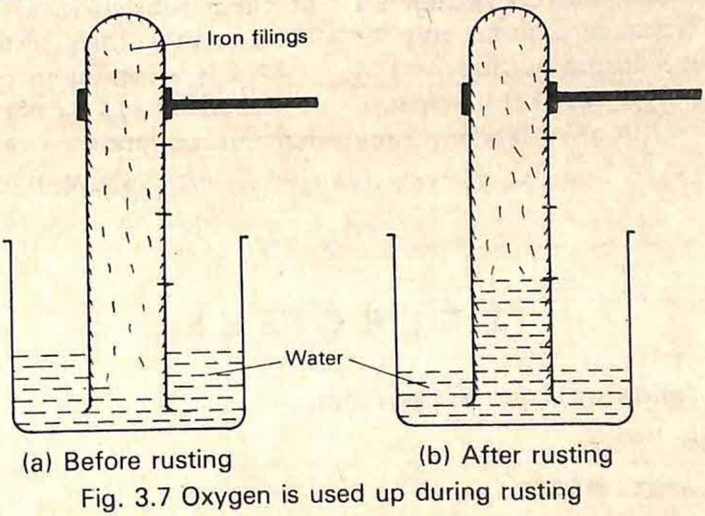
All of us know that when we leave shiny iron nails in a moist place, their outer surfaces become reddish-brown. We say that iron has **rusted.** The reddish-brown layer is called **rust** and the process of formation of rust is called **rusting.**

Experiment 6. Take a test tube and wet its inner surface. Put some unrusted iron filings in it and shake it so that the iron filings stick all over the inside of the test tube. Insert the test tube mouth downwards in a beaker containing water. Mark the level of water inside the test tube with the help of a small rubber band. Divide the space above the level of water in the test tube into five equal parts. Let the test tube stand in water for a few days. Note what happens.

You will see that the iron filings get rusted and that the water level inside the tube rises upto the first mark. That is, one-fifth of the air in the test tube is used up in the process of rusting.

Hold your thumb over the mouth of the test tube and turn the test tube upside down. Lift your thumb momentarily and introduce a burning wooden splinter into the tube. The wooden splinter is extinguished.

This experiment shows that when iron rusts, oxygen is used up and nitrogen is left behind. In this respect, therefore, rusting appears to be similar to burning.



(a) Before rusting (b) After rusting

Fig. 3.7 Oxygen is used up during rusting

Experiment 7. Weigh a clean crucible along with some dry iron filings. Sprinkle some water on the filings to wet them. Leave the crucible in a safe place. When the iron filings have rusted, drive the extra water away by gently heating the crucible over a flame. Weigh it again. You will find that the weight of the crucible has increased.

The experiment shows that there is an increase in weight when iron rusts. Again in this respect rusting is similar to burning. When iron rusts, it combines with the oxygen of the air in the presence of moisture to form iron oxide.

iron + oxygen $\xrightarrow[\text{and water}]{\text{in presence of air}}$ iron oxide

3.8 Rusting and Burning

Rusting and burning are similar. During burning of magnesium for example, it combines with oxygen of the air to form magnesium oxide. During rusting, iron combines with oxygen of air in the presence of water to form reddish-brown iron oxide.

magnesium + oxygen $\xrightarrow{\text{burning}}$ magnesium oxide

iron + oxygen $\xrightarrow{\text{rusting}}$ iron oxide (rust)

The only difference is the time taken for the reaction. Burning is fast, whereas rusting is a slow process. Heat is generated during both the processes. However, during rusting heat is produced at such a slow rate that it is lost to the surrounding without attracting any attention.

3.9 How to Stop Iron from Rusting

Rusting is a wasteful process as the iron is slowly 'eaten away' by rust. There are several ways by which rusting of iron can be prevented.

(i) Coat the surface of iron with a layer of oil, so that air and water do not come into contact with it. A better way is to paint the iron surface.

(ii) Coat the surface of iron with a thin layer of tin. This is done by dipping iron in molten tin. This process is called tin plating and it stops rusting.

(iii) By **galvanizing** iron, a process which consists of coating it with zinc. This is done by dipping iron sheets in molten zinc.

3.10 Pollution of Air

Air, particularly in industrial towns, gets polluted with traces of other substances. Burning of coal produces harmful gases such as **carbon monoxide** and **sulphur dioxide.** It also produces large quantities of unburnt carbon, tarry matter and fine dust particles. Incomplete combustion of petrol and diesel in car engines produces carbon monoxide. Most of these substances are harmful to human beings and to the growth of plants.

Man is becoming increasingly aware of his environment and the need to keep it free from harmful pollutants. Considerable efforts are now being made to minimise air pollution.

EXERCISES

1. Complete the following chemical equations.

carbon + oxygen $\xrightarrow{\text{burning}}$

phosphorus + oxygen $\xrightarrow{\text{burning}}$

magnesium + oxygen $\xrightarrow{\text{burning}}$

iron + oxygen $\xrightarrow{\text{rusting}}$

2. Fill in the blanks in the following sentences.

   (i) Rusting takes place in the presence of ______________________ and ______________________ .

   (ii) During the burning of magnesium the mass of magnesium oxide is ____________ than the mass of ______________________ because it has combined with the ______________________ present in air.

   (iii) In air the most active constituent is ______________________ and the most inactive constituents are ______________________ gases.

   (iv) The atmosphere extends into space for about ______________________ kilometres.

3 (a) Give two conditions necessary for iron to rust. ______________________

____

____

(b) State two ways of preventing the formation of rust. ______________________

____

____

4. Give a brief explanation for the following experimental results.

   (a) When 3 grams of oxygen is burnt in air the weight of resultant white ash is much more than 3 grams. ______________________

____

____

   (b) When 10 g of coal is burnt in air, the weight of the resultant grey powder is much less than 10 g. ______________________

____

____

5. (a) In which respect are burning and rusting similar? ______________________

____

____

(b) In which respect are they different? ______________________________

____

____

(6) Write the approximate percentage by volume of the following constituents of air.

Constituent	*Percentage composition*	*Constituent*	*Percentage composition*
Oxygen	______________	Noble or inert gases	______________
Nitrogen	______________	Water vapour	______________
Carbon dioxide	______________		

7. Large quantities of carbon dioxide are being added to air during burning of fuels and breathing. How then does the proportion of carbon dioxide in air remain almost constant?

____

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8. In which respect is breathing similar to burning? ______________________

____

____

9. Why is phosphorus kept under water in the laboratory? __________________

____

____

10. How can you show that one-fifth of air consists of oxygen? Draw the labelled diagram of the apparatus used.

____

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11. In which respects is exhaled air different from inhaled air?

12. Give reasons for the following.

(i) Lime water kept exposed to air *for long* turns milky.

(ii) Nitrogen is an inactive gas, even then it is useful. Give two reasons.

(iii) Iron rods in windows are painted.

13. Match the following

Carbon dioxide	is an inactive gas
Water vapours	percentage composition in air is 0.03% by volume
Nitrogen	condense as dew drops
Rusting	does not take place in dry air

4

Pressure

People living in top storeys of buildings often complain that they do not get enough water in their taps. Some buildings have pumps fitted to them which lift water upto a high level. The water is raised up to create the required pressure at the taps. If the pressure is not enough the water does not reach the taps in the upper storeys.

4.1 Pressure and Flow

Experiment 1. Prick a small hole in a balloon and then blow it. You will notice that the air inside the balloon rushes out through the hole. Why?

When a lot of air is squeezed into the balloon, the pressure inside increases in comparison to that outside. The air inside therefore rushes out through the hole. Thus we notice that *difference of air pressure is the cause for its movement.*

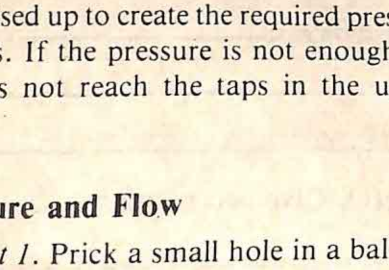


Fig. 4.1 Difference of air pressure causes movement of air

In cooking gas cylinders, gas is filled in under great pressure. When the tap is opened, excess pressure inside causes the gas to flow out freely. As the gas is used up, this difference in pressure gradually reduces. When the pressure inside becomes equal to the pressure outside a 'pressure balance' is obtained and no gas comes out.

4.2 The Pressure Gauze

You are well aware that tyres have to be 'inflated' with air. Those who own a scooter or car may have noticed that the excess air pressure in a tyre is measured by a meter called a **pressure gauze.** When you have a flat tyre, the meter reads zero; this means that the pressure of air is the same as that outside. How does a pressure meter work?

In order to measure excess pressure, it must cause some noticeable effect which we can record. One of these effects we have seen is a flow of liquid or gas.

Liquid Manometer

Experiment 2. Take a 3 metre long polythene tubing and fix it vertically in the form of a U-

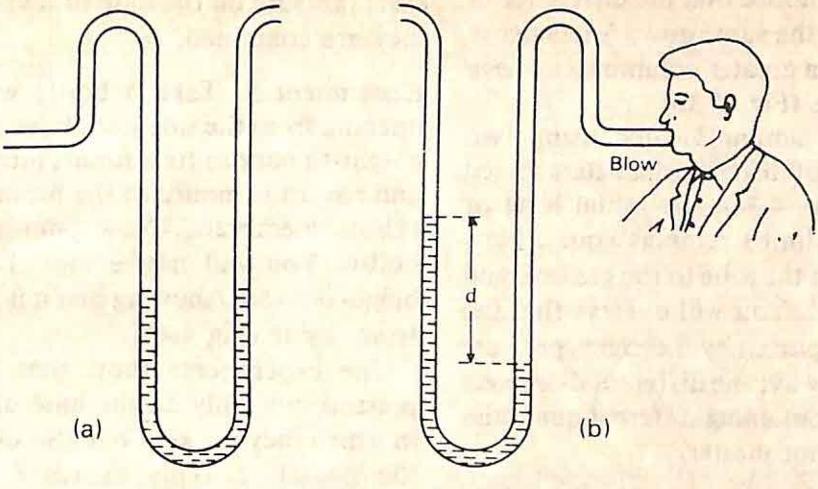


Fig. 4.2 A liquid manometer

tube; pour water from one end so that the water level is about 50 cm above the base (Fig. 4.2a). You will notice that the horizontal level of water in both limbs is the same. Now blow through one end as hard as you can. Note the change of water level, and the difference *d* in the two levels (Fig. 4.2b).

The difference in level *d* is an indication of your 'lung' pressure; it shows how much pressure your lungs can build up in excess of outside air pressure. Repeat the experiment by blowing through the other end. You will realise that water is pushed down in that limb but the difference in level remains unchanged.

4.3 Experiments with Pressure

Experiment 3. There are two other extensions of this experiment which you should try. Connect one end of the tube to the laboratory gas tap. The water column in the limb joined to the gas supply will be pushed down (Fig. 4.3a). The water column *p* will indicate the excess gas pressure. You can compare the gas tap pressure with your lung pressure.

Now replace water in the tubing with a liquid of low density such as kerosene or turpentine oil. Connect one limb to the gas tap again and note the liquid column supported by the excess

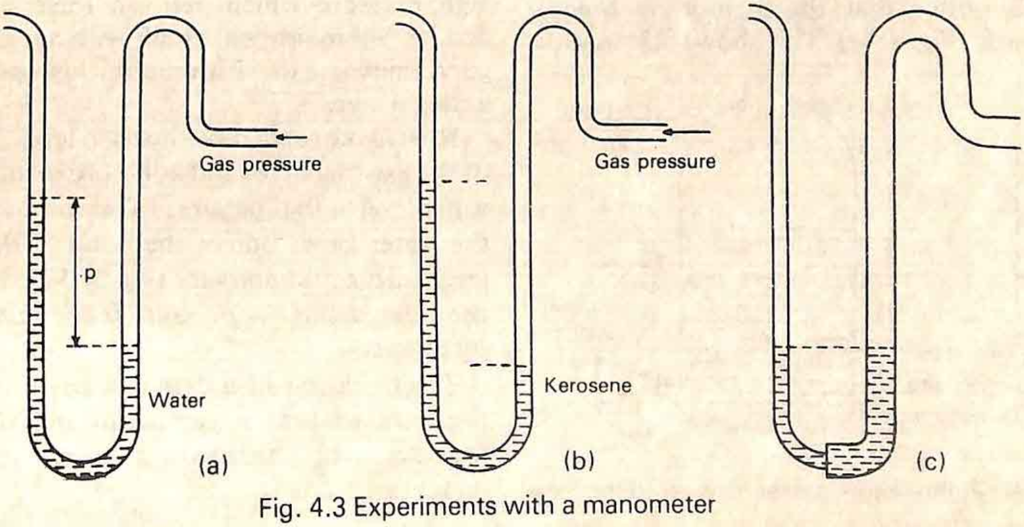


Fig. 4.3 Experiments with a manometer

pressure. You will notice that the difference in liquid levels is not the same now. A less dense liquid will require a greater column to achieve a pressure balance (Fig. 4.3b).

Next set up a similar U-tube using two polythene tubings of different diameters joined near the base (Fig. 4.3c); the initial level of water in the two limbs remains equal. Now connect one end of the tube to the gas tap, and then the other end. You will observe that the liquid column supported by the excess pressure is the same either way; the different diameters of the two limbs containing different quantities of the liquid do not matter.

This U-tube liquid apparatus, which indicates difference of pressures acting on the liquid surfaces in the two limbs, is called a **manometer.** To compare small differences in pressure, a liquid of low density is used because it creates a greater column of the liquid; thus, sensitivity of the instrument is increased. It may be noted that the diameter of the limbs is of no consequence, except that a wider tube will require more liquid.

4.4 Liquid Pressure

Experiment 4. Take a wide glass tube open at both ends and tie a thin rubber membrane at its lower end. Pour some water in the tube and you will notice that the membrane bulges downwards (Fig. 4.4a). This shows that liquids exert pressure on the base of a vessel in which they are contained.

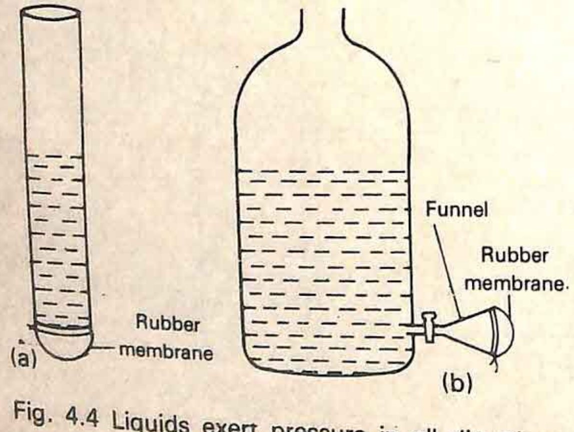


Fig. 4.4 Liquids exert pressure in all directions

Experiment 5. Take a bottle which has an opening from the side just above the base. Use a tight-fit cork to fix a funnel into the opening and cover the mouth of the funnel with a thin rubber membrane. Now pour water in the bottle. You will notice that the membrane bulges outward, showing that it is being pressed from inside (Fig 4.4b).

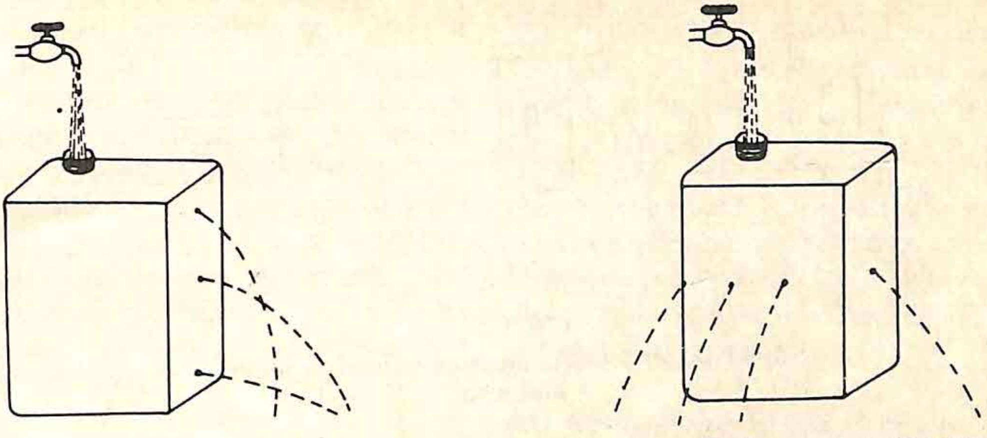
The experiments show that liquids exert pressure not only on the base of a container in which they are kept but also on the walls of the container. This existence of sideways pressure is one of the differences in the behaviour of solids and liquids.

Experiment 6. Take a polythene container and make a few holes in it at different levels. Hold it under a tap of running water to fill it fully and then adjust the opening of the tap so that water maintains its level. You will observe that the pressure with which water flows out increases according to the depth of the hole under the water surface (Fig. 4.5a). *The pressure in a liquid increases with depth.*

The fact that pressure in a liquid increases with depth finds extensive application. Deep sea divers wear a stout steel suit to withstand the high pressure which acts on them at great depths. Submarines are built with hard steel of good thickness to withstand the high pressures under water.

Now make some more holes in level with one of the existing holes and as before maintain the water level in the container. You will notice that the water flows out of the holes at the same level with equal pressure (Fig. 4.5b). Thus, *at the same depth the pressure is the same in all directions.*

The thickness of a dam is made broader at the base so that it can withstand the high pressure acting sideways as depth of water increases.



(a) Pressure in a liquid increases with depth

(b) At the same depth, pressure is same in all directions

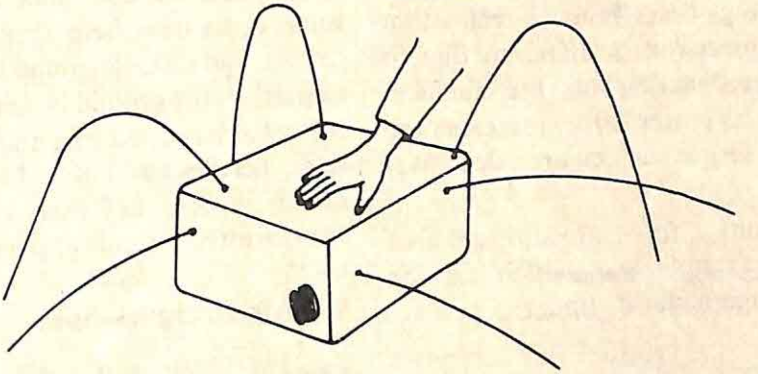


Fig. 4.5

(c) Pressure applied to an enclosed fluid is transmitted equally to all parts of the fluid

4.5 Transmission of Liquid Pressure

Experiment 7. Make some holes on various faces of the polythene container. Fill the container completely with water and close its mouth with the cap. Press it hard with your hand; you will notice that water spurts out in all directions (Fig. 4.5c). The water comes out with equal pressure through all the holes.

The result of this experiment can be summed up in the form of a law: *when pressure is applied to an enclosed fluid, it is transmitted equally to all parts of the fluid.* This is called **Pascal's principle.** The principle is applicable to gases as well.

4.6 Force and Pressure

Do you know why camels can walk without much difficulty in sandy deserts? What would happen if nails had sharp poins at both ends?

Experiment 8. Hold a drawing pin between your two fingers and press it as hard as you can. You will feel it painful only at the sharp end and there will be a deep mark due to it. It is very painful to carry a heavy parcel holding it with a thin string; hold the same load with a thick string and you feel much relieved.

Place a brick on soft plasticine or fine sand and it will create an impression on the surface (Fig. 4.6a). Two bricks, one on top of the other,

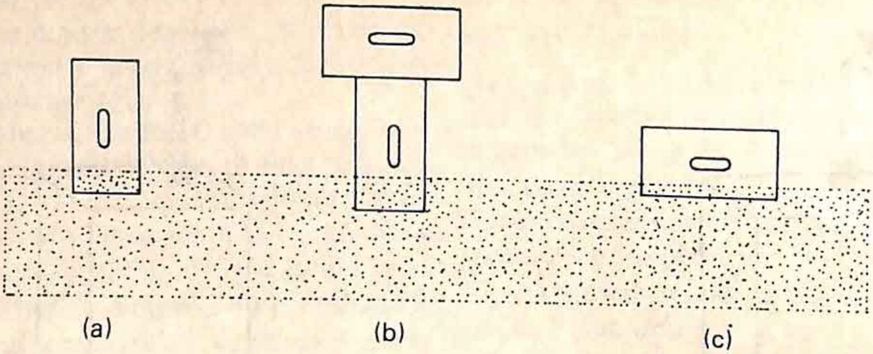


Fig. 4.6 Dependence of pressure on load (or force) and area

will make a deeper impression (Fig. 4.6b). Now place a brick on a wider base and the impression is shallow (Fig. 4.6c). You will realise that the depth of impression is different due to different pressures acting on the surface. Greater load (or a greater force) increases the pressure while a larger surface area decreases the pressure.

The three quantities, force, pressure and area are related in a simple way which can be expressed mathematically as under:

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

Thus pressure can be defined as the force acting per unit area. This explains why flat-footed camels can walk easily in sandy deserts. Heavy tractors can go through marshy land and muddy soil easily because their rear wheels have large areas. The caterpillar tracks of tanks and huge excavators help them to negotiate any uneven and sinking ground because the pressure exerted on the ground is comparatively less. On the other hand, cutting and piercing tools like saws, needles and knives have sharp points or blades so that they exert great pressure with comparatively small applied force.

4.7 Air Occupies Space

You know that matter exists in three forms—solids, liquids and gases. Air is a mixture of many gases, and is a form of matter. We know that matter occupies space and has weight.

Experiment 9. Take a basin full of water. Put a few drops of ink in the water to see it better.

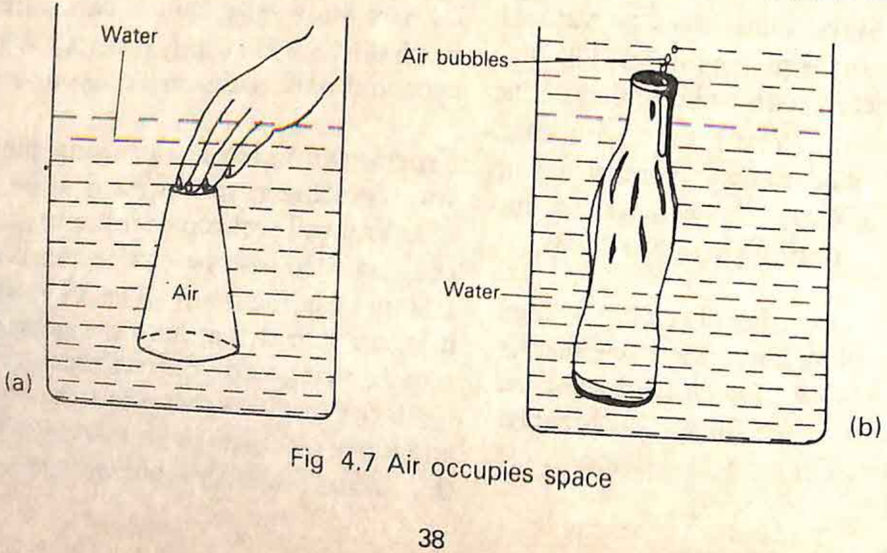


Fig 4.7 Air occupies space

Take an 'empty' glass and push it mouth downwards into the water. Does the water enter the glass (Fig. 4.7a)?

Water does not enter the glass when it is pushed mouth downwards in water, because the glass is not 'empty' but is full of air.

Now take an 'empty' bottle and push it under water mouth upwards. You will notice bubbles of air coming out of the bottle and water entering the bottle (Fig. 4.7b). The experiments show that *air, like wood or water, occupies space. The amount of space that any substance occupies is called its* **volume.**

4.8 Air Has Weight

Experiment 10. Take a deflated (empty) football and place it on the left hand pan of a balance as shown in Fig. 4.8a. Balance it exactly and note its weight.

Remove the football and pump air into it until it becomes hard. Put it back on the left hand pan of the balance and weigh it again. What do you notice? Where did the extra weight come from? This experiment shows that *like wood or water, air has weight* and so is one of the forms of matter. Light and heat do not occupy space and do not have weight. They are *not* examples of matter.

4.9 Atmosphere Exerts Pressure

The Earth is the only planet in our solar system which supports life, because it has an atmosphere of air and has water. Above the surface of the Earth upto 80 km or so there is

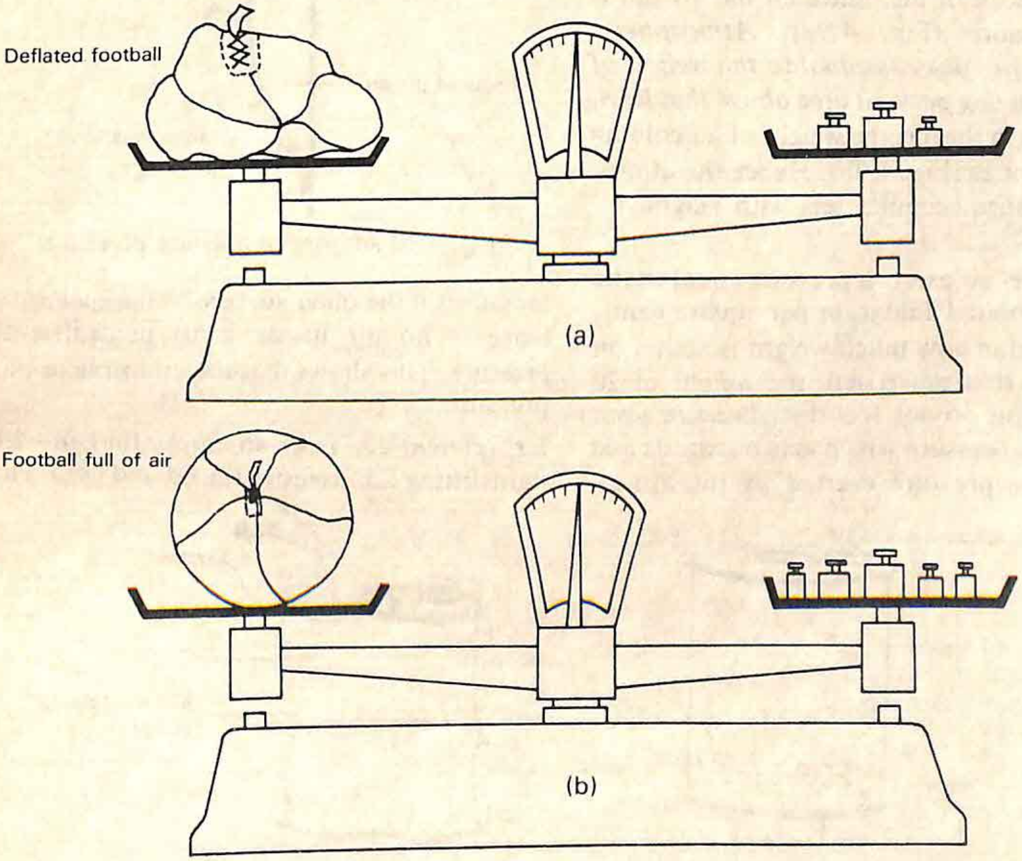
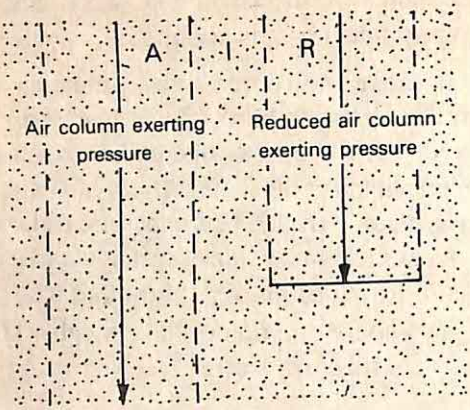


Fig. 4.8 Air has weight


A
R
Air column exerting pressure
Reduced air column exerting pressure

(a) (b)

Fig. 4.9

air. Most of it lies within 16 kilometres above the surface of Earth. We live at the bottom of this great ocean of air. Since air has weight it exerts pressure (Fig. 4.9a). *Atmospheric pressure at any place is equal to the weight of air column acting per unit area above that level.* As we go up in the air, the weight of air column above decreases (Fig. 4.9b). Hence the atmospheric pressure becomes less with height.

At sea level air exerts a pressure equal to the weight of about 1 kilogram per square centimetre. Imagine how much weight is acting on your body. It is more than the weight of 20 tons! But you do not feel this, because your blood exerts pressure which acts outwards and balances the pressure exerted by the atmosphere. At high altitudes, the blood pressure becomes more than the atmospheric pressure and you are likely to bleed through your nose and ears. To avoid this, modern aircrafts are pressurized and astronauts wear pressurized suits.

You can perform many experiments to show that atmosphere exerts pressure.

Experiment 11. Press a rubber sucker against a window pane to expel out the air (Fig. 4.10). Try to pull it out. You will find it difficult to do so. This is because the atmosphere exerts pressure on the outer surface of the sucker, and there is no air inside it to neutralise this pressure. This shows that the atmosphere exerts pressure.

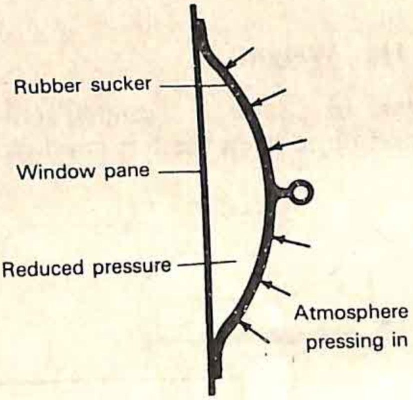


Fig. 4.10 Atmosphere exerts pressure

Experiment 12. Take an empty tin can with a tight-fitting lid. Remove the lid and pour a little

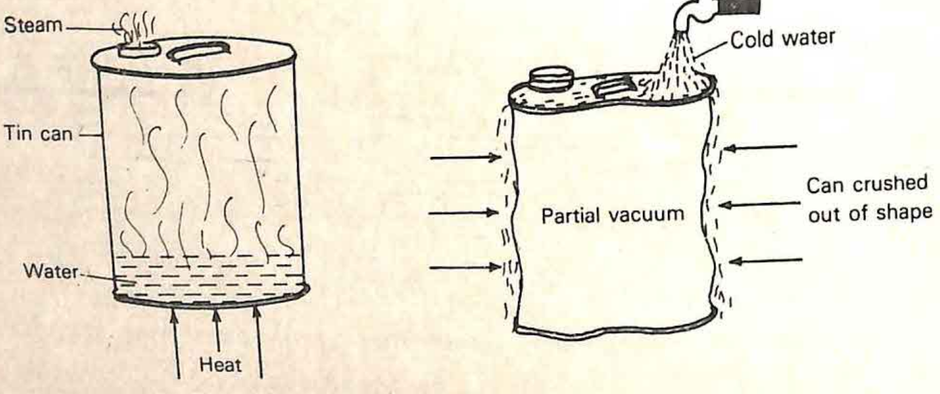


Fig. 4.11 Air exerts pressure from all sides

water into the can. Heat the can over a stove. Allow steam to escape. Now put the lid tightly on the can. Cool the can suddenly by pouring cold water over it. What do you see?

The lid will get jammed and the can gets crushed out of shape (Fig. 4.11). Why does this happen? When the can with water is heated, most of the air in it is driven away by steam. Now when the lid is put on and the can is suddenly cooled, the steam condenses to water. This leaves the space within the can partially empty and a partial **vacuum** is created. Now the atmospheric air exerts pressure on the can from all sides to crush it out of shape.

This experiment shows that air exerts pressure from all sides.

Experiment 13. You can demonstrate that air exerts pressure on all sides in yet another way.

Fill a glass tumbler upto the brim with water and place a thin cardboard over it without allowing air bubbles to enter into it. Hold the cardboard tight with your hand and invert the tumbler. Remove your hand. The cardboard will not fall down (Fig. 4.12a). How can it bear the weight of water within the tumbler? What holds it up? It is the air pressure that keeps the cardboard from falling.

Hold the cardboard tight once again and tilt the tumbler to one side as shown in Fig. 4.12b. What do you see? The cardboard stays in place. Turn the tumbler over to the other side carefully. The cardboard will not fall down. Thus air exerts pressure from all sides.

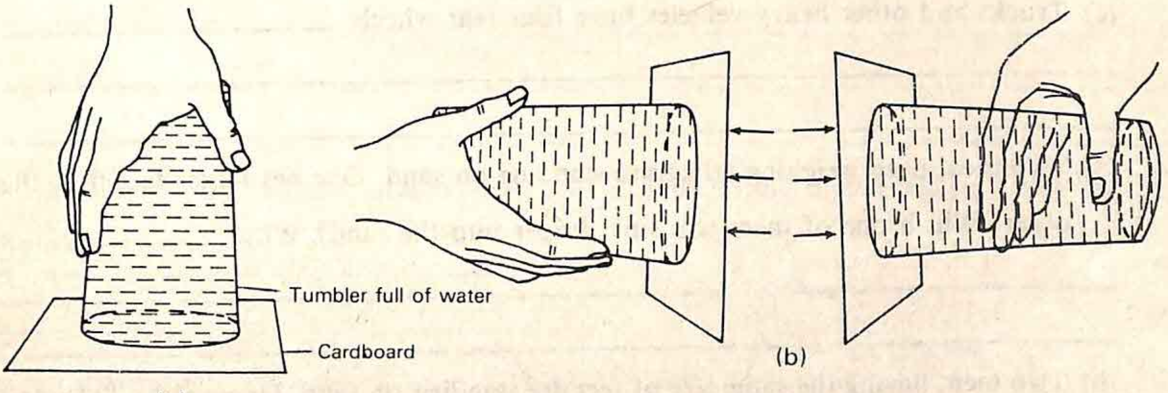


Fig. 4.12 Air exerts pressure from all sides

EXERCISES

1. Fill in the blanks.

(a) A gas flows from a region of ____________________ pressure to a region of ____________________ pressure.

(b) Excess pressure is measured by a ____________________.

(c) Pressure in a liquid ____________________ with depth.

(d) An increase in force will ____________________ pressure.

An increase in area will ____________________ pressure.

2. How does gas flow from the LPG cylinder to the burner? __________________

3. Explain the following:

   (a) A bubble of gas coming up from the bed of a lake gets larger in volume as it comes nearer the surface. __________________

   (b) Fishes that normally live at great depths in the ocean burst when brought to the surface.

   (c) Trucks and other heavy vehicles have four rear wheels. __________________

4. (a) Two men, both weighing 60 kg are standing on sand. One has larger feet than the other. Which one of them will sink deeper into the sand? Why? __________________

   (b) Two men, having the same size of feet are standing on sand. One weighs 70 kg and the other weighs 50 kg. Which one of them will sink deeper into the sand? Why?

5. Why is air considered a form of matter? Give two reasons? __________________

6. The weight of the air in the atmosphere pressing down on you is equal to 20 ton weight. Why do you not get crushed? __________________

7. Draw a labelled diagram of an apparatus to show that air has weight.

8. A man flies to a height of 15 km in an unpressurized aeroplane. What do you think will happen to him? ____

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9. In Fig. 4.13 the balloon inflates when the air is taken out of the bell jar. Why?

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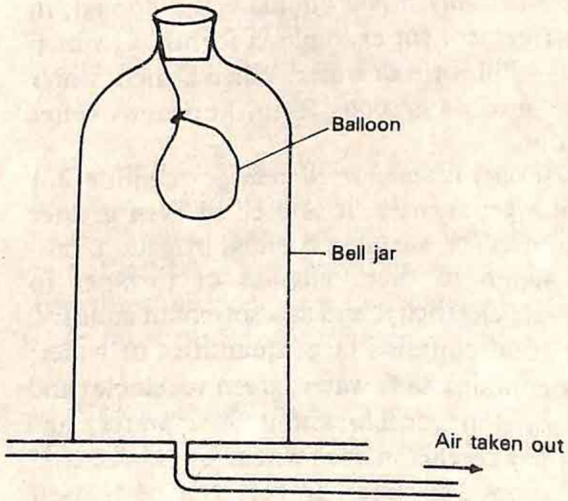


Fig. 4.13

5

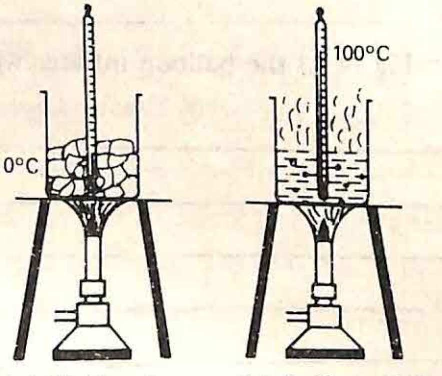
Water

The Earth is the only planet in our solar system which has both water and air. Life is impossible to imagine without them. Next to air that we breathe, water is the most common and necessary substance in nature. Three-fourths of the Earth's surface is covered with water. It exists in all the three forms—solid, liquid and gas. Normally it is a liquid. When cooled, in a refrigerator for example, it forms ice, which is the solid form of water. When heated, water turns into its gaseous form, known as water vapour.

Not only is water used in large quantities for drinking purposes, it is used in even greater quantities for washing, cooling, irrigation, raising steam to drive engines or turbines to generate electricity, and as a solvent in industry. Our food contains large quantities of water; milk contains 88% water; green vegetables and watermelon contain about 90% water, and even dry cereals such as wheat and maize contain about 3% water. In fact, our body itself consists of 60-70% water.

5.1 Change of State

Experiment 1. Take small pieces of ice in a beaker and fit a thermometer in it so that its bulb is surrounded by ice (Fig. 5.1a). Note the temperature. You will find that it is 0°C. Now slowly heat the beaker and note the temperature (Fig. 5.1b).



(a) Melting ice (b) Boiling water

Fig. 5.1 Change of state in water

The ice begins to melt first but the thermometer continues to show a temperature of 0°C. *The temperature at which ice changes into water is called the* **melting point** *of ice.* Conversely *the temperature at which water changes into ice is known as its* **freezing point.**

When the whole of the ice has melted, the temperature will be seen to rise till the water begins to boil. Bubbles of steam will then be seen to rise up and burst on reaching the surface, thus liberating steam in the air. So long as the water keeps boiling, the temperature will be seen to remain constant at around 100°C. *The fixed temperature at which water changes into gaseous steam is called its* **boiling point.** The change of state from a liquid to a gas at a constant temperature is called **vaporization.** The change of state from liquid to a gas does not only take place as its boiling point. It occurs at all temperatures. For example, wet clothes dry in the sun because of evaporation of water from them; perspiration soon evaporates and disappears when we sit in front of a running fan. *This change of state from a liquid to a gas at any temperature is called* **evaporation.** Water is continuously evaporating from the surfaces of oceans, lakes, rivers and ponds and is changing into water vapours which go into the air. Thus air always has water vapour in it. Let us perform an experiment to show the presence of water vapour in air.

Experiment 2. Place a beaker on a table and put cubes or pieces of ice into the beaker. You will notice that at first the outer surface of the beaker becomes misty. This is due to **condensation** of water vapour in the air on the cool beaker walls. Soon, as more water condenses, drops of water can be seen trickling down the beaker walls. This is like the formation of a cloud followed by rain.

5.2 The Water Cycle

Water evaporates continuously from the surface of seas, rivers and lakes and from vegetation on land. It rises and forms clouds in the sky. When cooled sufficiently, water vapour condenses into droplets of water, which come down as rain, or even as snow or sleet if it is very cold. It eventually finds its way back into rivers and seas, thus completing the cycle (Fig. 5.2). Thus water is never lost from the Earth and its atmosphere. *This circulation of water from the Earth's surface to the sky and back to the Earth is called the* **water cycle.** Part of the rain water seeps into the Earth's crust and penetrates the soil till it reaches a layer of impervious rock. This water appears as a spring or may be brought to the surface when a well is sunk.

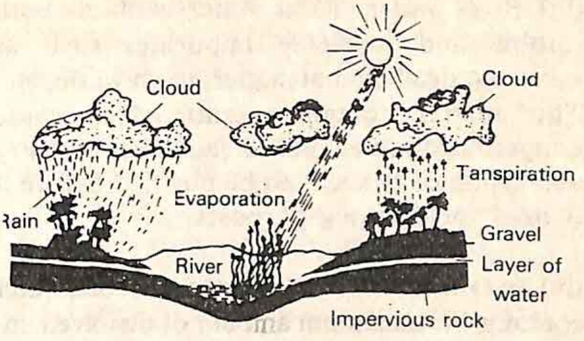


Fig. 5.2 The water cycle

Air is a great store house of water vapour. Attempts are being made by scientists to utilise this water vapour to create artificial rain in times of drought.

5.3 Sources of Water

Water in nature can be classified into four types.

(i) *Rain water:* While coming down through the air, rain water collects dust particles and dissolves some gases, mainly carbon dioxide. After the first few showers, as dust is cleared from the atmosphere, the rain water we receive is the most pure form of natural water.

(ii) *Spring or well water:* Part of rain water seeps into the ground and penetrates the soil till it reaches a layer of impervious rock. This water appears in the form of springs. While percolating down the soil, it dissolves in it several compounds. If we dig deep to reach the undergound water level, a well is formed. From this, water can be pumped or drawn out.

(iii) *River water:* River water contains both soluble and insoluble impurities such as minerals, dead animal matter, town waste, etc. This matter contains germs which cause dangerous diseases such as jaundice, dysentry and typhoid. It needs to be purified before it is used for drinking purposes.

(iv) *Sea water:* Rivers flow into seas. Sea water contains the maximum amount of dissolved impurities (about 3.5%). Out of this, about 2.5% is common salt (sodium chloride).

5.4 Water as a Universal Solvent

Almost all substances dissolve in water to some extent. Even when you are drinking a glass of water, some dissolved glass find its way into your stomach! There is no cause for alarm, however, as the quantity is so small that no harm is done. Let us perform an experiment to show the presence of dissolved impurities in different forms of water.

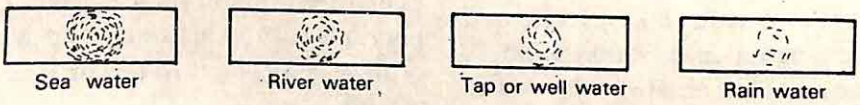


Fig. 5.3 Dissolved impurities in water

Experiment 3. Put a few drops each of rain water, tap or well water, river water and if possible, sea water on separate glass slides. Keep the slides in the sun till the water evaporates. Now observe the slides carefully. You will notice that rain water hardly leaves any residue while sea water leaves the maximum residue (Fig. 5.3).

This shows that sea water contains the maximum amount of dissolved impurities and rain water the minimum amount. When a substance (solute) is dissolved in water (solvent) it forms a **solution** of the substance in water.

5.5 Removal of Suspended Impurities

Suspended impurities such as mud, dead animals, twigs and humus etc. can be removed by processes known as **decantation** and **filtration.**

1. Sedimentation and Decantation

The impure water is kept undisturbed in a container for a long time. Tiny particles of mud or silt are thereby allowed to settle down (sedimentation) at the bottom. The clear water is then decanted off with the help of a glass rod, leaving the impurities behind (Fig. 5.4).

In city water supply schemes, suspended impurities are allowed to settle down in huge sedimentation tanks. However, this rough and rapid method does not remove all the suspended impurities.

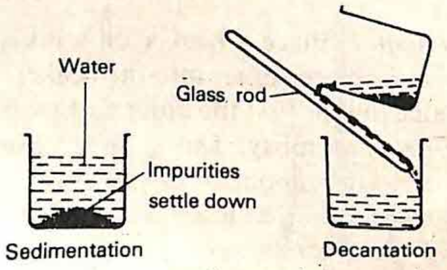


Fig. 5.4 Sedimentation and decantation

2. Filtration

Experiment 4. Fold a piece of circular filter paper first into two to make a semicircle, and then into four to make a quarter-circle as shown in Fig. 5.5. Open it out so that a cone is formed (Fig. 5.5). Fit the filter paper into a moist funnel so that it sticks to the sides of the funnel. Place the funnel into a test tube and gently pour the muddy water into the funnel. Never allow the funnel to be more than three-quarters full with muddy water otherwise the water is likely to run down between the filter paper and the funnel.

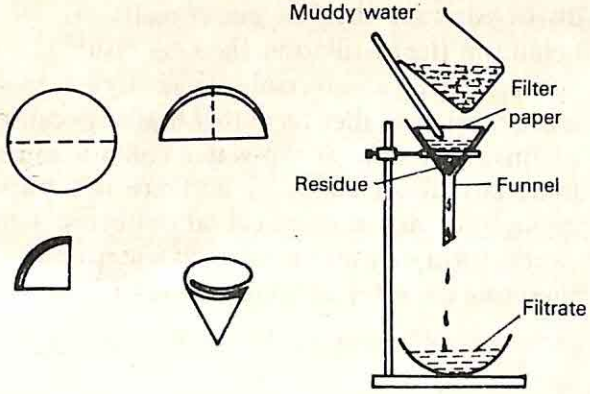


Fig. 5.5 Filtration

A filter paper has very small holes through which water can pass. The dust or mud particles are too big to pass through these holes, and thus are separated or filtered off from the water. The clear water collected in the test tube is the **filtrate** and the mud particles collected on the filter paper form the **residue**. Filtration is a slow process but with it all the suspended impurities can be removed.

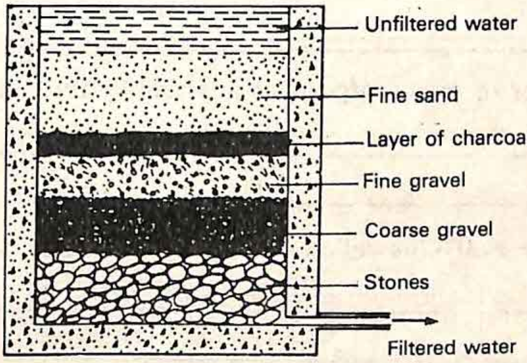


Fig. 5.6 Sand filter

5.6 Town Water Supply

A town usually gets its water supply from rivers. During its journey river water gathers suspended impurities such as soil, dead animal matter, twigs and also germs. These must be removed before the water is fit for drinking. The following methods are employed to purify water for domestic purposes.

(a) *Sedimentation:* Water is allowed to flow through large settling tanks where bigger particles settle down at the bottom.

(b) *Filtration:* Water is then passed through sand filters. These consist of layers of sand, gravel and stones. All left over suspended impurities are removed by these filters.

(c) *Chlorination:* River water also contains harmful germs which may cause diseases such as cholera, dysentry, jaundice and typhoid. Therefore it is essential to purify this water before it is used for drinking purposes. This is done by chlorination. Water is pumped into chlorine towers where a steady stream of chlorine is passed through it to kill the germs.

Boiling of water also destroys germs. It is always better to boil water before it is used for drinking to make sure that all germs have been destroyed.

5.7 Distillation

On boiling a liquid, it changes into its vapours. The vapours can be condensed back to the liquid by cooling them. This process of evaporation of a liquid and the subsequent condensation of the vapours is known as **distillation.** By the help of distillation we can remove soluble impurities from water.

Experiment 5. Add some sugar or salt to water and stir to dissolve. Half fill a **distillation flask** with the salt solution and set up the apparatus as shown in Fig. 5.7.

Heat the distillation flask with a bunsen burner, till the water begins to boil. Water vapours thus formed are allowed to pass through the inner tube of a **Liebig condenser** and condense into tiny droplets of water which collect in the receiver. The water collected in the receiver is called the **distillate** and is very pure. When all the water has boiled off, the

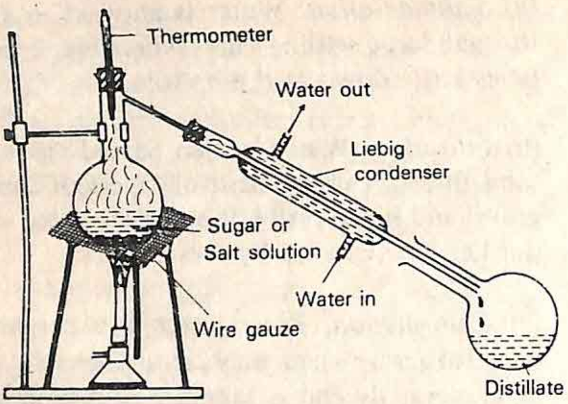


Fig. 5.7 Distillation

dissolved impurities (sugar or salt) are left behind in the distillation flask as residue.

Water being a universal solvent, it dissolves more substances then any other liquid. Because of this, all forms of tap-water contain some materials dissolved in it, and are not pure enough for use in chemical laboratories. The purest form of water is distilled water and we therefore use it for all accurate work in science.

EXERCISES

1. Correct the following statements:
   (a) After a few showers rain water contains more impurities. ______
   (b) Common salt is insoluble in water. ______
   (c) Boiling is the change of state from water to water vapour at any temperature. ______
   (d) The process of change of water into ice at 0°C is called condensation. ______
   (e) By decantation one can remove soluble impurities. ______

2. Fill in the blanks in the following sentences.
   (a) The substance which is soluble is water is called a ______ and the resulting product is called a ______.
   (b) Water is said to be a ______ solvent.
   (c) ______ water is the purest form of water. ______ water is the purest form of natural water.

(d) The temperature at which ice melts is ______________ . It is called its ______________ point.

3. State how

(a) evaporation differs from boiling. ______________

(b) decantation differs from filtration. ______________

4. Define

(a) Melting point ______________

(b) Boiling point ______________

5. Give reasons for the following.

(a) Water supplied in a city is chlorinated. ______________

(b) Drinking water should be boiled. ______________

(c) Sand is used in water filters. ______________

(d) Sea water is salty. ______________

6. Draw a neat labelled diagram of the process of filtration.

7. Name

(a) three waterborne diseases.

(i) ____________________

(ii) ____________________

(iii) ____________________

(b) two ways by which suspended impurities present in water can be removed.

(i) ____________________

(ii) ____________________

(c) two ways by which germs present in water can be killed.

(i) ____________________

(ii) ____________________

(d) two substances soluble in water.

(i) ____________________

(ii) ____________________

6

Temperature and Volume

Heat is something about which most of us already know a lot. It is used to cook our food, to press our clothes, to drive the engines of cars and trains and to do thousands of other useful works.

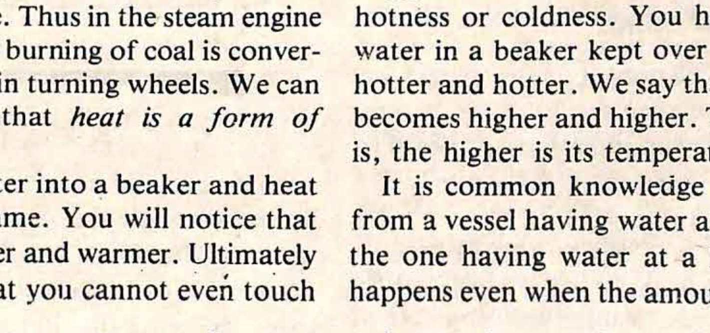
Even when we know a lot about heat, it is difficult to describe it because it is not something we can see, smell or taste. In steam engines when we burn coal, heat is produced which turns water to steam. Steam under pressure pushes the piston of the engine and makes the train move. Thus in the steam engine heat produced by the burning of coal is converted into energy used in turning wheels. We can therefore conclude that *heat is a form of energy.*

Pour some tap water into a beaker and heat the beaker over a flame. You will notice that water becomes warmer and warmer. Ultimately it becomes so hot that you cannot even touch the beaker. Thus heat *is a form of energy which makes objects feel warmer.*

6.1 Heat and Temperature

You will be familiar with the word 'temperature'. You must have heard people say on a hot day, 'the temperature is very high today'. On a cold day you will find people commenting 'the temperature is very low today'. This suggests that temperature is a measure of hotness or coldness. You have seen that the water in a beaker kept over a flame becomes hotter and hotter. We say that its temperature becomes higher and higher. The hotter a body is, the higher is its temperature.

It is common knowledge that water flows from a vessel having water at a higher level to the one having water at a lower level. This happens even when the amount of water in the



Direction of water flow

Water flow stops

Fig. 6.1a Water flows from a higher level to a lower level

former vessel is less than in the latter vessel. This goes on till the levels of both the vessels are same (Fig. 6.1a). Similarly heat always flows from a body at a higher temperature to the one at a lower temperature till the temperatures of both bodies are same (Fig. 6.1b). We can, therefore, say that *temperature determines the direction of flow of heat when a body is placed in contact with another body.*

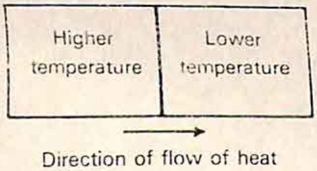


Fig. 6.1b Heat flows from a body at higher temperature to a body at lower temperature

6.2 Temperature and Volume

A number of physical properties change with temperature. Among these the most important is the change in volume. Most objects expand when they are heated and contract on cooling. Gases expand the maximum and solids the minimum.

6.3 Expansion of Solids

Solids expand on heating, but the expansion is too small to be seen easily. This is why carefully designed experiments are required to show this effect.

Experiment 1. Take a ball and ring apparatus as shown in Fig. 6.2. At ordinary temperature the ball can just pass through the ring. When the ball is heated over a flame it is noticed that it no longer passes through the ring. On cooling it contracts and again passes through. This clearly shows that the ball expands when it is heated and contracts when it is cooled.

During the expansion and contraction of solids tremendous forces come into play. This can be shown by the bar-breaker apparatus as shown in Fig. 6.3.

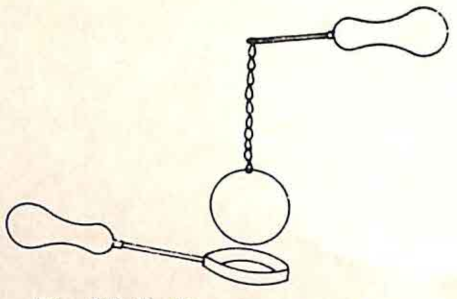


Fig. 6.2 Solids expand on heating

Experiment 2. The bar-breaker apparatus consists of a strong iron frame holding a steel rod. One end of the rod is threaded so that it can be screwed. Through a hole near the other end a small cast iron pin is slipped in. The steel rod is heated strongly with a flame from a blow-burner and when it is hot the nut is tightened. On cooling, as the rod contracts, the cast iron pin is found to break up into many small pieces, showing thereby that the rod exerts a strong force on contraction.

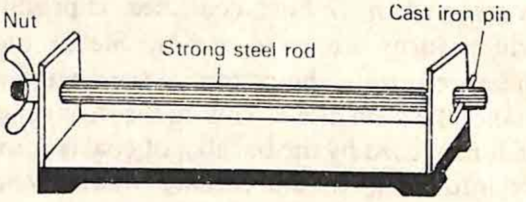


Fig. 6.3 The bar-breaker apparatus

Different metals of the same length when heated through the same rise of temperature show different expansions. The rates of expansions of brass and aluminium are almost twice that of iron. Platinum and glass show almost equal expansions on heating. This is why a platinum wire can be fused in a glass rod while a copper or brass wire cannot be fused in it.

Experiment 3. Take a bimetallic strip having two equal strips of brass and iron riveted

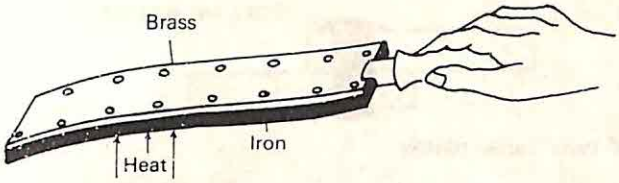


Fig. 6.4 A bimetallic strip bends on heating

together firmly. On heating it is noticed that the strip bends with brass on the outer side of the bent curve (Fig. 6.4). This shows that the brass strip expands more than the iron strip.

6.4 Expansion and Contraction in Everyday Life

Expansion of solids poses problems for engineers. Sometimes the expansion is used to our advantage. But very often, the large forces that accompany expansion and contraction of solids are a disadvantage in engineering. A few simple examples are described in the following.

The Railway Track

The mid-day sun, specially in summers, causes the railway lines to become hot. The lines expand. If no space is left between two sections of the railway line to allow for expansion, the lines may bend and cause derailment of trains. Gaps are, therefore, always left between two sections of a railway line so as to give space for them to expand (Fig. 6.5a).

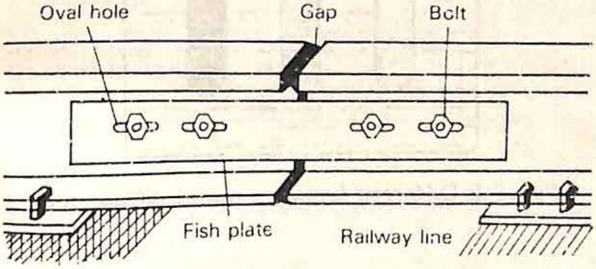


Fig. 6.5(a) Gaps are left between sections of a railway line to allow for expansion

At each gap, the two sections are joined by fish plates clamped to the rails by bolts as shown in Fig. 6.5a. In order to allow movements of rails at the joints the holes through which bolts pass are made oval in shape.

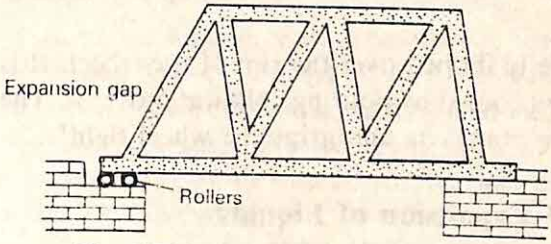


Fig. 6.5(b) Expansion gap in a bridge

For the same reason, while constructing bridges, gaps are left for the bridges to expand in summer as shown in Fig. 6.5b.

Cracking of Glassware

You might have noticed that a thick glass tumbler breaks when very hot water or tea is poured into it. The hot liquid causes the inside of the tumbler to get heated up more than the outside. Therefore, the inner walls expand more than the outer walls. The strain thus set up is too much for the glass and it cracks. Pyrex glass expands less and so is less likely to break. A 'pyrosil' dish can be placed straight into a refrigerator from a hot plate cooker without cracking.

Riveting

Two metal plates or beams can be riveted together by utilizing the large force set up during contraction. Holes are drilled in the two plates to be joined and a red hot bolt or rivet is placed through them. It is then hammered flat while still red hot and is cooled by pouring water over it. The force of contraction thus set up pulls the plates tightly together (Fig. 6.6).

Fixing Metal Tyres

Wheels of trains, locomotives, etc. are fitted with steel tyres. They are of slightly smaller diameter than the wheels. They are heated strongly so that they expand. The hot expanded

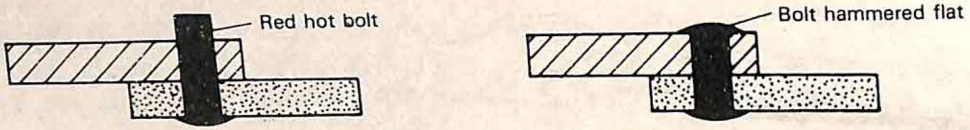


Fig. 6.6 Riveting of two metal plates

tyre is slipped over the rim of the wheel. It is then cooled by pouring cold water over it. The tyre contracts and grips the wheel tightly.

6.5 Expansion of Liquids

Liquids expand when heated and contract on cooling. The expansion and contraction is much more than in solids, and can easily be seen.

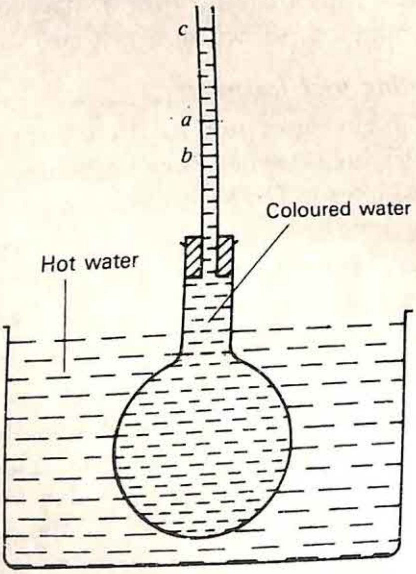


Fig. 6.7 Liquids expand on heating

Experiment 4. Fill a round-bottomed flask completely with coloured water and insert a rubber stopper carrying a narrow tube into its neck such that some of the coloured water rises a short way up the tube. Mark the position *a* of the coloured water. Now insert the flask into a can of hot water and record the level of water in the tube. It is noticed that first the level falls down a little to *b*. This is due to the expansion of the flask. It then rises above *a* to *c* due to the expansion of water. This clearly shows that water has expanded more than the flask (Fig. 6.7).

Different Liquids Expand Differently

Experiment 5. Take three boiling tubes of the same size and fill them respectively with alcohol, water and mercury. Insert rubber stoppers carrying long narrow tubes of the same bore in the boiling tubes. Place the boiling tubes in a large beaker of water and leave them there for some time. Check that all the liquid levels are the same. If necessary add a little more liquid in the tube in which the level is lower.

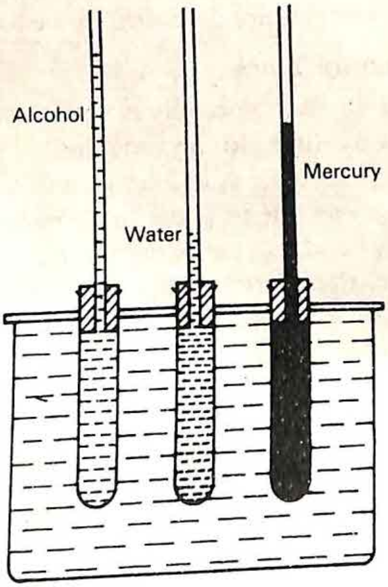


Fig. 6.8 Different liquids expand differently

Now gently heat the water in the beaker and keep it stirring all the time to ensure uniform temperature of the bath. It is found that alcohol expands the maximum and water the least (Fig. 6.8).

6.6 Expansion of Gases

Experiment 6. Fix a tight-fitting rubber cork and a tube into a 500 ml flask and support it as shown in Fig. 6.9. Place a beaker filled with water under the open end of the tube. Warm the flask gently over a flame. You will notice air bubbles coming out of the water. This shows that air expands on heating. Now allow the flask to cool. Water is seen to rise up the tube. This shows that air contracts on cooling.

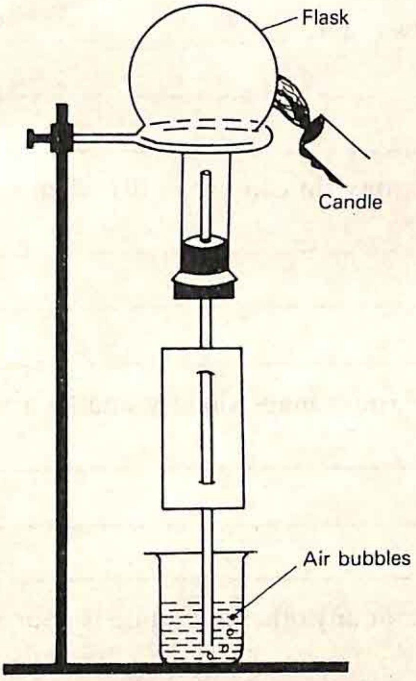


Fig. 6.9 Expansion of gases

Wait till the water level becomes steady. Now warm your hands by rubbing against each other and hold the flask in your hands. The heat from your hands expands the air in the flask and forces water down the tube. Cool the flask by passing running water over it or by holding a few cubes of ice around it. The air contracts and the water level rises up the tube.

Now observe the water level carefully against a scale held next to it several times during the day. You will find that the temperature changes during the day are enough to cause considerable expansion and contraction of air. In this experiment we have actually made a devise which can be used to record changes in atmospheric temperature. Such a devise that records temperature is called a **thermometer.** However, our thermometer needs to be **caliberated** against a standard thermometer to enable us to read the actual atmospheric temperature.

EXERCISES

1. Fill in the blanks in the following sentences.

(a) In a car engine, ____________________ is produced by the burning of ____________________

(b) Heat flows from a body at a ____________________ temperature to a body at a ____________________ temperature till the temperatures are ________

(c) Solids expand ____________________ than liquids, while gases expand ____________________ than liquids.

(d) Heat is a form of ____________________ and temperature is a ________ of hotness or coldness of a body.

2. Equal volumes of air, oil and iron are heated from 20°C to 30°C. List them in the order of expansion.

(i) ____ (ii) ____ (iii) ____

3. Explain why:

(a) a gap is left between two sections of a railway line. ____

(b) a lid pushed tightly into the mouth of an empty tin can blows off when the can is heated. ____

(c) in order to put a steel rim onto a wheel, the rim is made slightly smaller and is then heated to a high temperature. ____

(d) a thick glass tumbler cracks when boiling tea or any other hot liquid is poured into it.

(e) A cork stuck into the neck of a bottle can be taken out by heating the neck of the bottle.

4. (a) Out of mercury, alcohol, and water which expands the maximum and which expands the least? ____

(b) If two strips of equal length, one of iron and the other of brass are heated from 20°C to 100°C, which expands more? ____

5. Draw the appearance of the bimetallic strip shown in the diagram after it is cooled.

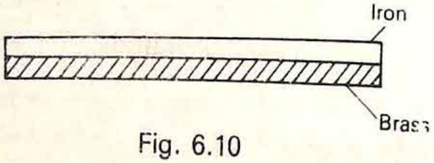


Fig. 6.10

6. (i) A flask is fitted with a long thin tube and is filled with coloured water as shown in Fig. 6.11. The flask is then plunged into a very hot water bath. How will the liquid level change? ____

____

____

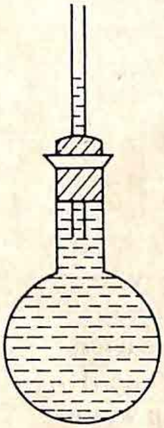


Fig. 6.11

(ii) What change will be observed if mercury is used instead of water? ____________

____

____

7

Transfer of Heat

You have already learnt that heat always tends to flow from a hot object to a cooler one. If you pick up a cold spoon, heat from your warm fingers will flow to the spoon making it warm. At the same time your fingers will feel cool because heat has gone out of them to the spoon. If you hold a hot spoon, heat from the hot spoon will flow into your fingers and your fingers will feel warmer. At the same time the spoon will get cooler.

To find out how heat is transferred from one body to another, let us perform some experiments.

7.1 Conduction

Experiment 1. Clamp a metal rod horizontally in a retort stand. Cut small studs of wax from a candle and fix them on the rod along its length as shown in Fig. 7.1.

Heat one end of the rod. As heat reaches a wax piece, it melts and falls down. You will notice that after some time the wax piece closest to the heated end melts and falls off. The other pieces fall off one by one. The piece nearer to the heated end falls off before the one further away. This shows that heat energy is transmitted through the metal from the hot end towards the cold end. This process of transfer of heat is called **conduction.**

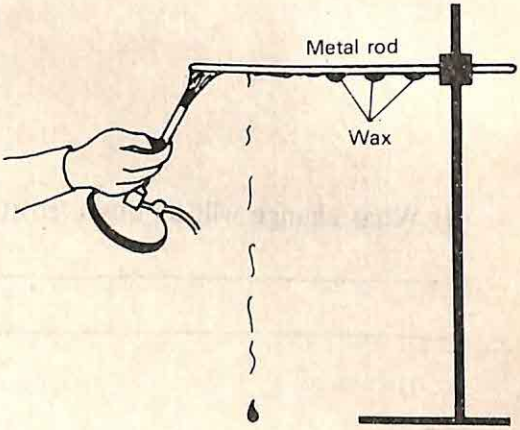


Fig. 7.1 Conduction

While heat is being conducted along the rod, you will observe that there is no movement of metal particles along the rod. Thus, during conduction, heat moves from particle to particle, without the particles themselves moving.

7.2 Good and Bad Conductors

Experiment 2. Hold one end of an iron rod in your hand and put the other end over a candle or a bunsen burner flame. After some time the rod becomes too hot to hold. Repeat the experiment with a similar copper rod. It is observed that the heat reaches the other end much more quickly in the copper rod. If a glass rod is used instead, the other end remains comfortably cold even while the end over the flame becomes red hot.

The experiment shows that there is a wide difference in the ability of iron, copper and glass to conduct heat. Materials such as copper, aluminium and brass which conduct heat quickly are called **good conductors** of heat. On the other hand materials such as glass, cork and wood which conduct heat very slowly are called **bad conductors** of heat or **insulators.** Most metals are good conductors of heat. Silver and copper are the best conductors. Copper conducts heat about eight times faster than steel.

Uses of Good and Bad Conductors

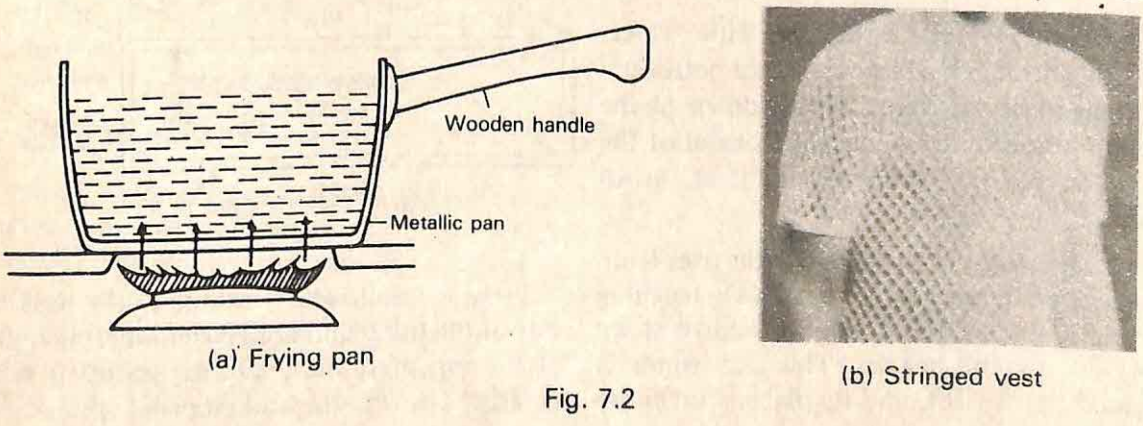
Both good and bad conductors have their uses. Frying pans, kettles and other cooking utensils are made of good conductors such as brass, aluminium and iron. Copper, though a very good conductor, is not used for cooking utensils because it reacts with food to form poisonous materials.

Insulators have comparatively wider applications. Handles of kettles, pans, etc. are often made of bad conductors such as plastic and wood. They do not heat up and can be held comfortably.

Air and all other gases are bad conductors of heat. In winter, a string vest is preferred over an ordinary one even when it is full of holes. This is because when a shirt is worn over it, air is trapped in the holes between the shirt and the vest. Air being a very poor conductor does not allow the heat of our body to escape to the atmosphere. Wool is warmer than cotton because it is full of tiny pockets of air enclosed by the fibres of the material.

Heat losses by conductors through the walls of an oven are minimised by constructing ovens of double walls and packing the space between them with glass wool. Glass wool is a very poor conductor of heat. The use of non-conducting material to reduce escape of heat is called **lagging.** Those of you who have been to a hill station in north India such as Nainital or Mussoorie during winters must have observed that water pipes exposed to the atmosphere are covered with jute or felt. This is done to minimise the loss of heat from the water to the atmosphere. This prevents freezing of water in the pipes. This is another example of lagging.

Experiment 3. Put some ice inside a boiling test-tube. Push a piece of wire gauze through the tube so that it traps the ice inside. Now fill up the tube with water and hold the open end carefully over a burner flame. The water soon



(a) Frying pan

(b) Stringed vest

Fig. 7.2

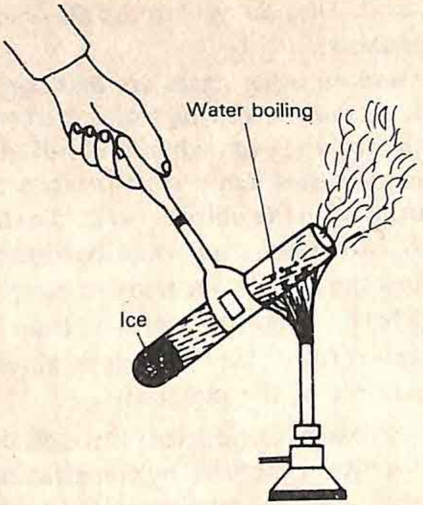


Fig. 7.3 Water is a poor conductor of heat

begins to boil but the ice is still not fully melted (Fig. 7.3). If the experiment is repeated by heating the tube from below with ice floating on top, ice quickly melts.

Actually, water is a poor conductor of heat. This is why even when water is boiling at the top, ice trapped below it does not melt. All liquids other than mercury and molten metals are bad conductors of heat. However, we have seen that when the water is heated from below with ice floating on top, the ice quickly melts. This shows that heat flows easily upwards in liquids. There must therefore be a method other than conduction which helps this process.

7.3 Convection

Experiment 4. Fill a beaker with water. Carefully drop in it a large crystal of potassium permanganate so that it settles down at the bottom in the centre. Heat the bottom of the beaker with a very small gas flame as shown in Fig. 7.4.

It is observed that coloured water rises from the place where the heat is applied. On reaching the top it spreads out and comes down along the sides of the beaker. Thus, as water is warmed up, it rises, and its place is taken by cold water from the sides. This forms currents in water (Fig. 7.4). These currents are known as **convection currents.** This process continues till the whole of the water gets heated. You will notice that the currents are set up because warm water rises up. This happens because *water, on heating, becomes lighter.*

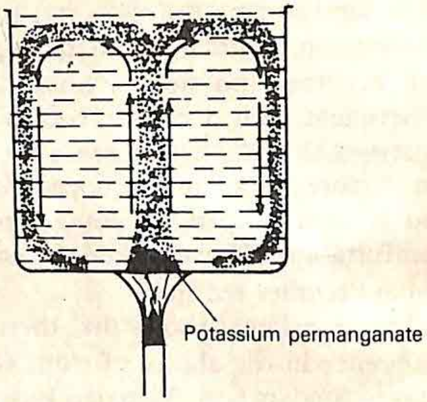


Fig. 7.4 Convection in water

Experiment 5. Convection in air is shown by using the apparatus shown in Fig. 7.5. It consists of a rectangular box with two wide glass tubes projecting from the top and having a removable glass front.

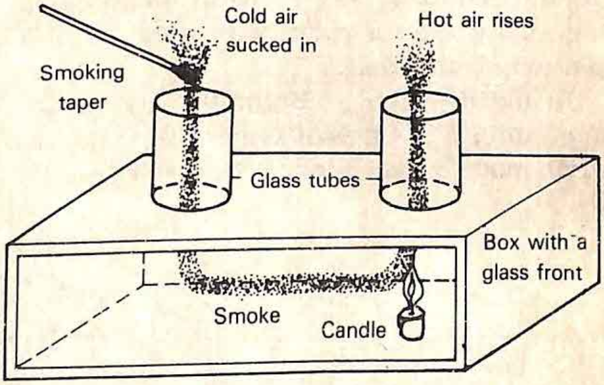


Fig. 7.5 Convection in air

Place a small lighted candle at the base of one of the tubes and hold a smouldering taper at the top of the other tube. Smoke is seen entering down the tube over which the smouldering taper is held, rising above the candle and leaving from the tube above it.

Air above the candle becomes warmer and lighter and moves up. Its place is taken by fresh air sucked in from the top of the other tube.

Experiments 4 and 5 show that *convection is a process of transfer of heat in which the heated particles of a fluid go from one place to the other.* In a solid the particles are much more firmly bound together and cannot move freely. Hence convection is not possible in solids.

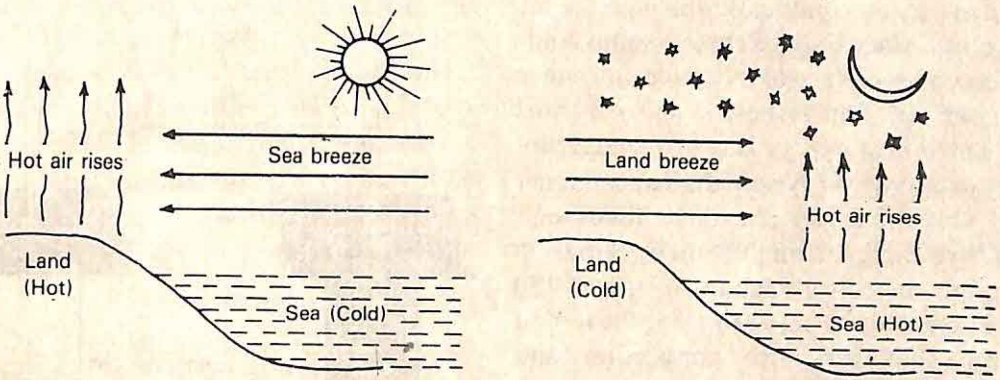


Fig. 7.6 Land and sea breezes in coastal places

Convection currents in a refrigerator are set up exactly in the opposite way. The freezing chamber is at the top. The air coming in contact with it gets cooled and becomes denser. The cold dense air then moves down and its place is taken by warmer air from below. The convection currents thus set up keep the foodstuff cold.

7.4 Applications of Convection

A common example of convection in nature is the setting up of land and sea breezes (Fig. 7.6). At coastal places the land gets hot quicker during the day; as the air above it becomes warm and rises, its place is taken by cool breeze flowing from the sea (Fig. 7.6a). At night the land cools quicker than water in the sea. The air above the sea rises and a breeze flows from land to sea (Fig. 7.6b). Coastal areas therefore are not very hot during the day or cold during the night.

Ventilation is a practical example of the use of convection currents used to keep rooms cool and fresh. The air we breath out is warmer and rises. Its place is taken by fresh air coming inside from the windows. Ventilators at the top provide outlet for the stale and warm air.

Hot water systems in many hotels and houses are based on the principle of convection. It

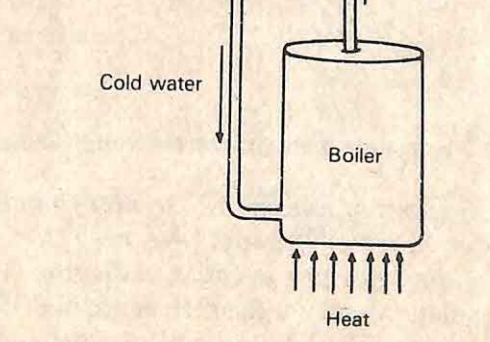


Fig. 7.7 Principle of a hot water system

consists of two tanks. The lower tank is called the boiler. Here the water is heated. Hot water from the boiler rises and goes into the upper tank, from where it is taken out for use. As the water is used up, cold water from the supply system enters the circulation to be heated in the boiler.

7.5 Radiation

If you stand in front of a fire on a winter day you feel hot. The heat you receive certainly does not come to you by conduction through the air or the ground, since both of these remain cold. Neither do you receive heat by convection since hot air rises up. You receive heat by a third way, in which heat energy is transferred from one body to another in exactly the same manner as light. This third way is called **radiation.**

We receive energy from the Sun by radiation even though there is a vacuum of about 150 million kilometres in between (Fig. 7.8). You have seen that for both convection and conduction some medium is required for transfer of heat from one place to another. Radiation of heat, however can take place without a medium.

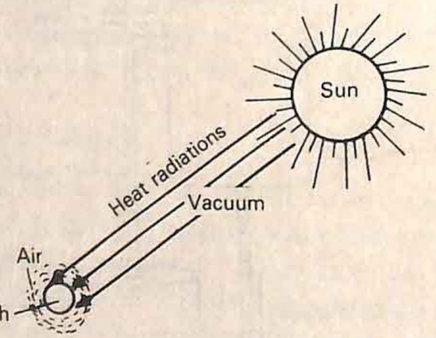


Fig. 7.8 Heat radiations can travel through vacuum

The process of transmission of heat from one place to another without the need for an intervening medium is called **radiation.** The heat radiations are not themselves hot but when they are absorbed by an object, the object becomes hot.

Experiment 6. Take two identical tin cans. Paint one of them black and keep the other shining from outside. Fill them half with water. Cover them with cardsheets holding thermometers, and place them on a table in the open under direct sunlight. Note the mercury levels in the two thermometers which would show that the temperature of water in the beginning of the experiment is the same (Fig. 7.9). In a few minutes the thermometer in the black can will be seen to record a greater rise in temperature.

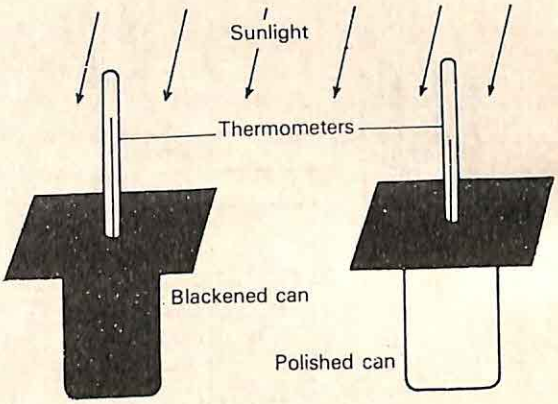


Fig. 7.9 Black surface absorbs heat radiations better than a polished surface

Now replace the water in both the cans with hot water. Place them in the shade and record the temperature. In a short time it would be noticed that the water in the black can cools faster than that in the polished can.

The first experiment shows that a black surface absorbs heat radiations better than a polished surface. A polished surface reflects most of the heat radiations falling on it while a black surface absorbs it. The second experiment shows that a black surface radiates out heat more effectively than a polished surface. White or polished surfaces are thus good reflectors but poor radiators of radiant heat. For this reason, white and light coloured clothes are preferable in summer than dark coloured clothes. In winter, dark clothes feel warmer. The back of a refrigerator and hot plates are coloured dull black to radiate heat effectively.

7.6 Thermos Flask

A thermos flask is a household appliance in common use to keep things warm or cold. It consists of a double-walled glass vessel in a metallic case and is separated from it by cork supports. Air between the walls is evacuated and the inner surface of the outer wall and the outer surface of the inner wall are silvered. The mouth is closed by a cork (Fig. 7.10).

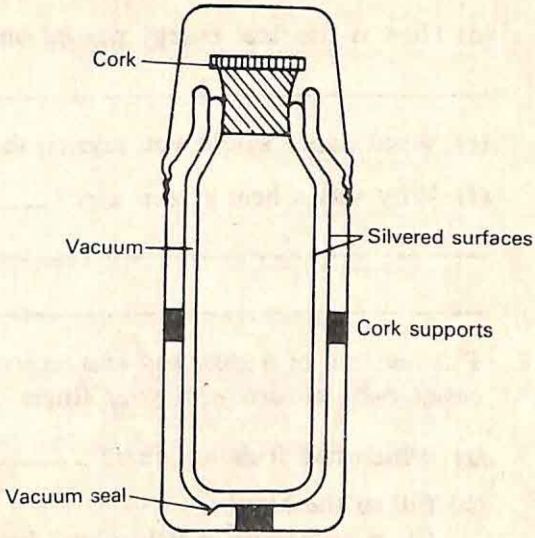


Fig. 7.10 Thermos flask

Because of the vacuum between the two walls, flow of heat either way by conduction and convection is considerably minimised. This is because both conduction and convection need particles for heat transfer. Since polished surfaces are bad absorbers and good reflectors of heat, loss of heat by radiation is reduced. Loss of heat by evaporation is stopped by closing the mouth by a nonconducting cork.

EXERCISES

1. Use wax to stick 4 drawing pins onto one end of a metal rod as shown in Fig. 7.11. Leave a gap of about 3 cm between each drawing pin. Place a heat screen under the rod between the burner and the pins. Heat the rod.

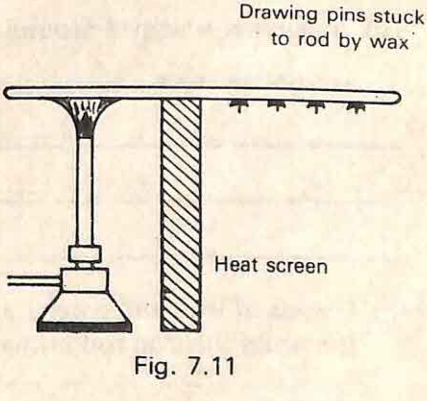


Fig. 7.11

(a) Which drawing pin falls first? ______________

(b) Why do the pins fall off? ______________

____

____

____

____

____

(c) Do the particles in the rod move along the rod as they are heated? ______________________________

(d) How is the heat energy passed on? ______________________________

____

(e) What name would you give to this method of flow of heat? ____________

(f) Why was a heat screen used? ______________________________

____

____

2. Put one end of a glass rod and an iron rod into a large beaker of hot water. Touch the other ends in turn with your finger.

   (a) Which rod feels hot first? ______________________________

   (b) Fill in the blanks.

      (i) A substance which allows heat energy to pass through it is called a ________ ______________ of heat. A substance which does not allow heat energy to pass through it is called a ____________ ___________ of heat.

      (ii) The above experiment shows that ____________________ is a good conductor of heat and ____________________ is a bad conductor of heat.

3. Explain why

   (a) A cemented floor feels cold to the bare feet in winter but a carpet in the same room feels comfortably warm. ______________________________

   ____

   ____

   ____

   (b) A blanket wrapped around our body in winter keeps us warm, but helps a block of ice not to melt. ______________________________

   ____

   ____

   ____

   (c) If rods of iron and copper are held in hand and their other ends are placed over fire, the tip of the iron rod becomes red hot while that of the copper rod does not become red hot. ______________________________

   ____

(d) In coastal areas during the day, the breeze flows from the sea to the land.

4. (a) Fill a large test-tube almost to the top with cold water. Hold a thermometer over it so that the bulb just dips in water. Heat the water at the base of the tube for 60 seconds. Is there any rise of temperature? How is heat carried to the thermometer?

   (b) Take another tube with fresh cold water. Place the bulb of the thermometer at the bottom of the tube. Heat the water at the top of the tube for 60 seconds. Is the rise of temperature less or more than in case (a)?

   How is heat carried to the thermometer in this case?

   (c) What do you conclude from the above experiment?

5. Distinguish between conduction and convection.

6. Fill in the blanks.
   (a) Heat energy can travel without the need for any ______.
   This way of heat travel is known as ______.
   (b) When a fluid (liquid or gas) is heated, the heated ______ move from one place to another, carrying heat with them. This way of heat travel is known as ______

(c) A ____________________ surface absorbs heat radiations better than a ____________________ surface. However, a ____________________ surface radiates heat better than a ____________________ surface.

7. Explain how in a thermos flask heat losses due to the following are minimised.

(a) Radiation ____

____

____

(b) Convection _______________________________________

____

____

(c) Conduction _______________________________________

____

____

8

Light

In an absolutely dark room we cannot see anything around us. Strike a match or switch on the light, and the things around us become visible. We can then see the table, the chairs, the books, the floor and everything else in the room including ourselves. Turning on the light brought about this change. We can thus say that light is something which enables us to see things around us.

Is light the only thing required for seeing? Close your eyes and you will not be able to see the objects . A blind man cannot see even in daylight. Thus to see the objects not only light but also eyes are essential. We see an object only when *our eyes receive light from the object*.

8.1 Sources of Light

The main natural sources of light are the Sun and the stars. The Sun is a huge ball of blazing hot gases that gives off heat and light. The stars, like the Sun, are also huge balls of hot gases. However, they are very much further away than the Sun. They are therefore only seen as tiny pinpoints of light twinkling in the sky.

A lightning flash during a storm is also a natural source of light.

A light source made by man is called an artificial source. At first man used fire to produce light. Today electric light bulbs and fluorescent tube lights are most commonly used. Artificial light is essential for us today.

All objects which give out light of their own, e.g. Sun, stars, glow worm, burning match-stick, glowing electric lamp, etc. are called **luminous** *objects.*

Most of the objects that we see around us e.g. chair, book, blackboard, etc. do not emit their own light and are called **non-luminous** objects. An electric lamp becomes non-luminous when it is switched off. The Moon is a non-luminous object. Moonlight is actually the reflected light of the Sun. These non-luminous objects become visible when light from luminous objects falls on them and some of it is reflected into our eyes.

8.2 Is Light Itself Visible?

Quite often people say, 'I see light in the room'. Actually we are seeing the illuminated parts in the room. In a cinema hall, a beam of light is seen from the projector to the screen. However, if we observe carefully, we notice dust and smoke particles floating in the path of the beam. If you shine a torch from end to the other in a clean and dust-free room, you will hardly see any beam of light. But, strike a duster against a hand to scatter chalk dust in the path of light, and the beam of light will appear to be visible. Outer space appears black to an astronaut travelling in a spaceship although we know that light from the Sun and stars comes to us through outer space.

We may conclude therefore that *light itself is invisible* but when it falls upon objects, they become visible.

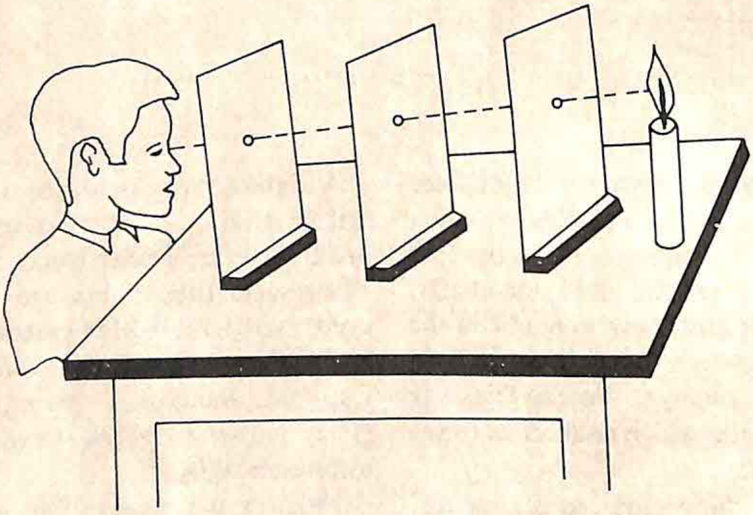


Fig. 8.1 Rectilinear propagation of light

8.3 Light Travels in Straight Lines

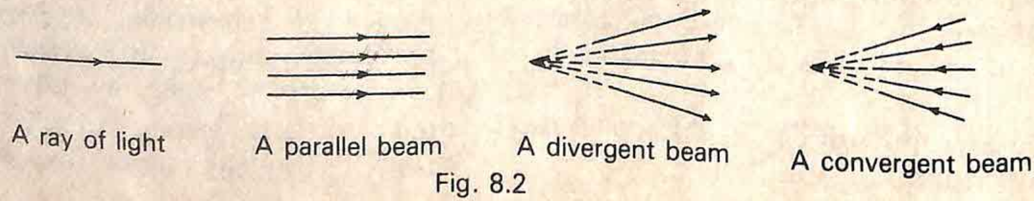
How does a beam of light in a cinema hall appear to travel? Early in the morning the Sun's rays streaming in between the leaves, their path made visible by moisture and dust, appear to go in straight lines. If you shine a torch at night in the open, the beam of light shows a straight path. Searchlights looking for an aeroplane, or the revolving searchlights used by circus shows, can be seen to go outwards in straight lines.

Experiment 1. Take three cardboard pieces and make them stand vertically as shown in Fig. 8.1. Make a small hole in each one of them at exactly the same height from the table. Place a lighted candle at one end so that its flame is at the same level as the holes. Look through the holes from the other end and adjust the cardboards so that the eye, flame of the candle and the three holes are in one straight line. You can then see the flame.

Now slightly disturb one of the cardboards. Can you seen the flame? Again adjust the cardboards so that the flame can be seen once more. You will observe that the flame can be seen only when all the three holes are in a straight line joining the flame and the eye.

This experiment shows that light travels along a straight line. This is called **rectilinear propagation of light.**

A very narrow path of light is called a **ray** of light. A ray of light is shown in a diagram



A ray of light

A parallel beam

A divergent beam

A convergent beam

Fig. 8.2

by a straight line, which an arrowhead showing the direction in which it is travelling (Fig. 8.2). A collection of rays of light is called a **beam** of light. A beam of light can be **parallel, divergent** or **convergent.** A parallel beam of light is one in which rays of light are parallel to each other. Rays of light reaching us from a very far off object, such as the Sun, are almost parallel to each other. In a divergent beam rays of light emerge from a point object and spread away from each other. In a convergent beam, rays come towards each other.

8.4 Opaque, Transparent and Translucent Objects

In Experiment 1 we noticed that light cannot pass through a cardboard. Hold your palm in the path of light between two cardboards and you can obstruct the light reaching your eye. *Such objects through which we cannot see because they do not allow light to pass through them are called* **opaque.** Name two other opaque objects.

Now hold a glass block in the path and find out if the flame is still visible. *Such objects through which light can easily pass are called* **transparent.**

When we look outside a classroom through a window pane we are looking through two transparent objects; glass and air. Some window panes are however, not very clear; they allow light to pass through them partially. You may have seen bulbs which give out light but whose filaments cannot be seen; such glass is called **translucent.** Greased paper, thin polythene sheets and tracing paper are examples of translucent objects. They allow light to pass through partly but we cannot see clearly through them.

8.5 Shadows

When you stand in the sun, you see your shadow formed on the ground. The shadows

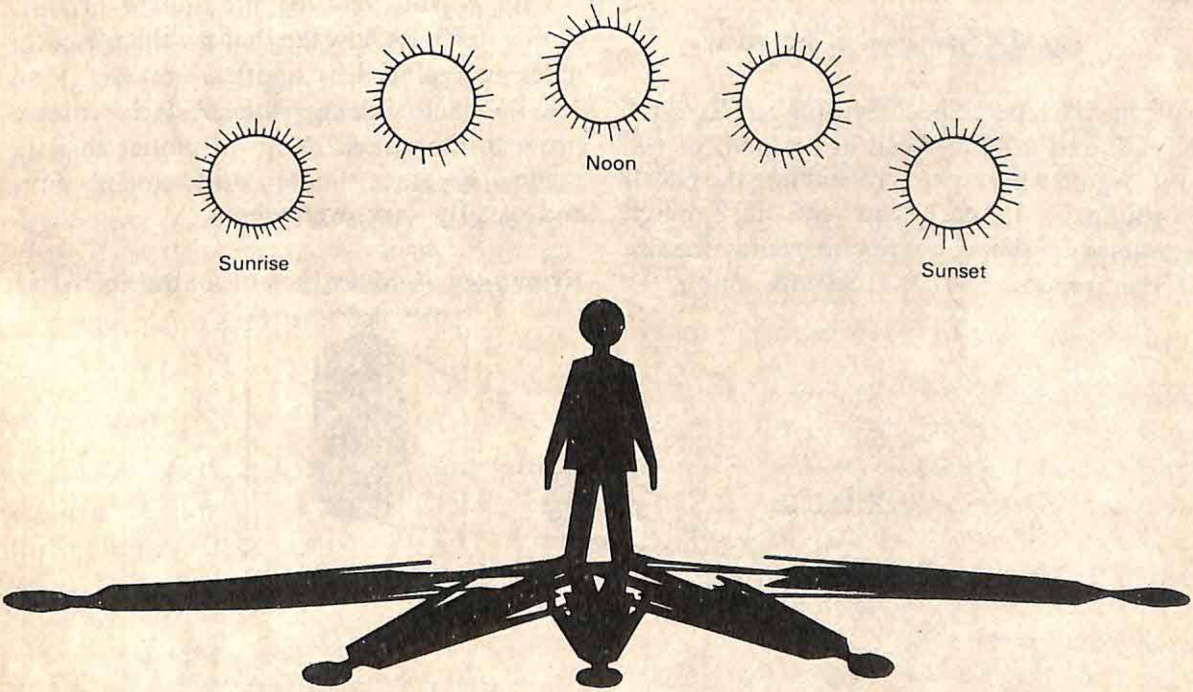


Fig. 8.3 Shadows at different times of the day

have different lengths at different times of the day because of the changing position of the Sun. When the Sun is near the horizon, in the early morning or evening, a long shadow is formed by the Sun's rays. Its directions depends on whether the Sun is rising or setting. When the Sun is overhead at midday the shadow cast is the shortest. This changing direction of the shadow is used in the *sun dial* for telling the time.

Experiment 2. In a darkened room shine a torch towards a wall and hold an opaque object, say a ball, in the path of light. You will see a dark patch on the wall. Move the ball closer to the wall, the dark patch becomes smaller. Remove the ball and hold a pencil in the path of the light. Again a dark patch resembling the pencil is obtained. In each case the dark patch resembles the shape, but not necessarily the size of the object. The size depends upon the distance of the object from the wall. This dark patch is called the **shadow**. It is clear that the shadow is the area on the screen from which light is cut off by the wall or the pencil.

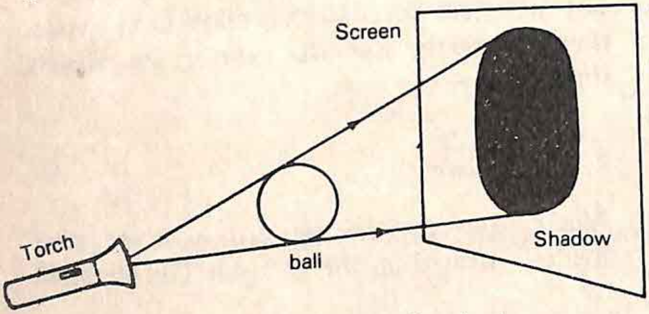


Fig. 8.4 Formation of a shadow

We can say that *when an opaque object is placed in between a source of light and a screen, the area of the screen from which the light is cut off is called a* **shadow.**

Experiment 3. A very small source of light L, usually called a **point source,** is prepared by covering an electric bulb with a cardboard box and making a small hole in the box. This arrangement is called a **light box**. Hold an opaque sphere in the path of light and observe the shadow (Fig. 8.5). A ray from L to X will go straight to the screen and illuminate it. The rays LB and LD will go just grazing along the surface of the sphere and reach the screen at points E and F, respectively. Between B and D, all other rays of light will be stopped by the sphere.

Why is only half of the sphere brightly illuminated? See how the shadow changes if the sphere is replaced by another obstacle. How does the shadow change if the obstacle is moved closer to the screen? You will notice that the shadow becomes smaller, and remains sharp and equally dark everywhere.

Experiment 4. Make the hole in the box bigger

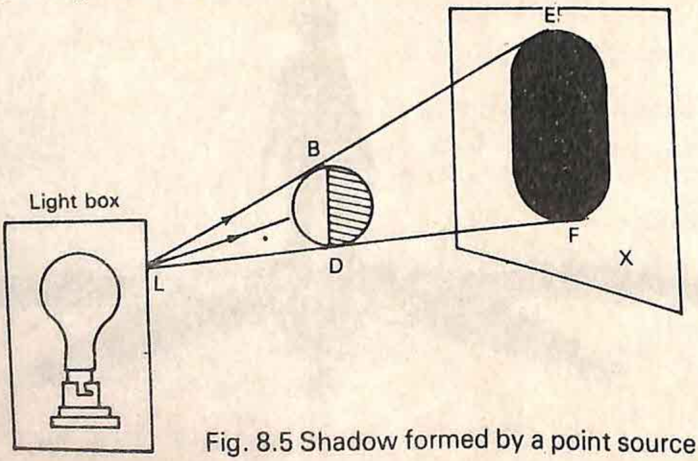


Fig. 8.5 Shadow formed by a point source of light

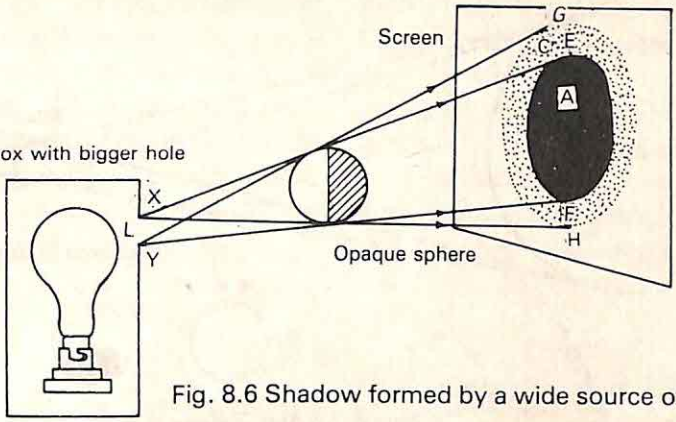


Fig. 8.6 Shadow formed by a wide source of light

so that you have a wide source of light and again study the shadow of the sphere. You will find that the shadow is not sharp this time. One faint and one dark shadow appear to be overlapping. Actually there are two different parts of the same shadow. The dark part of the shadow between E and F (Fig. 8.6) receives no light at all and is called **umbra;** an eye situated at A within the shade of the umbra region would see no part of the source L. The fainter part of the shadow is called **penumbra** and in this part light is only partially cut off. An eye at C within the shade of penumbra region would see the top part, including X, of the source L but not the lower part which includes Y. Outside GH the screen would receive light from the entire source. How would the shadow change if the screen is moved away from the source? You will observe that both the umbra and penumbra regions become larger.

8.6 Eclipses

The Sun is about four hundred times larger than the Moon, but it is also about four hundred times farther away from us. For this reason, the Sun and the Moon appear to be of the same size in the sky.

The Sun is a luminous object while the Earth and the Moon are opaque and non-luminous. The Earth revolves around the Sun once in a year and the Moon revolves around the Earth once in about 29 days. It happens sometimes that all three come in one straight line and either the shadow of the Moon falls on the Earth of that of the Earth falls on the Moon; thus eclipses are caused. Eclipses are shadows formed on cosmic scale and are based upon the fact that light travels in straight lines.

Solar Eclipse

The solar eclipse is caused when the shadow of the Moon falls on the Earth (Fig. 8.7). At places on the Earth which fall in the umbra, like *a* in Fig. 8.7, the Sun is completely blocked by the Moon and total eclipse of the Sun is observed from there. Places which fall in the penumbra experience a partial eclipse as in the case of *b* and *c*.

It is necessary to remember that, during an eclipse, the Sun should not be viewed directly with the naked eye. It should be viewed only through a smoked screen or an exposed film.

Because of the small size of the Moon in relation to the Sun, the umbral cone is very narrow and can form a shadow at most 270 km wide. The total solar eclipse, therefore, can be seen only from a few places on the Earth. Moreover, due to the fast movement of the Moon and the rotation of the Earth, the shadow moves away rapidly from the surface of the Earth; the total solar eclipse at any place, therefore, never lasts more than seven minutes.

It is clear that during a solar eclipse the

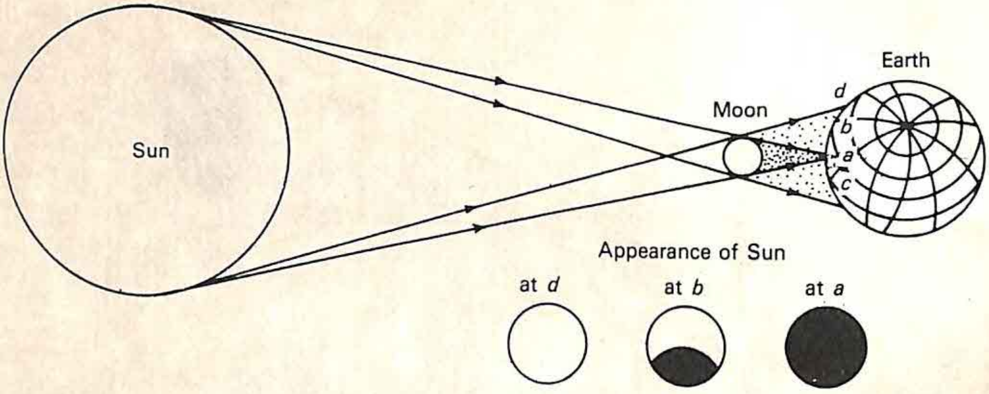


Fig. 8.7 Solar eclipse

lighted portion of the Moon faces away from the Earth. Thus a solar eclipse takes place only on a new Moon day. However a solar eclipse does not occur on every new Moon day as the Sun, the Moon and the Earth do not come in a straight line on every new Moon day.

Lunar Eclipse

Eclipse of the Moon occurs on a particular full Moon day when the Earth comes between the Sun and the Moon and they are in one straight line. In this condition the shadow of the Earth falls on the Moon. The eclipse is partial when the Moon is partly in the umbral shade and total when the whole disc of the Moon is in the umbra (Fig.8.8).

The lunar eclipse is seen from the entire half of the Earth facing the Moon. Since the umbral cone of the Earth is comparatively larger and the Moon is comparatively smaller, the lunar eclipse lasts for a much longer duration, from a few minutes to even over an hour.

8.7 Reflection of Light

A non-luminous object can be transparent, opaque or translucent. When light falls on it, one or more of the following may happen: (a) light may pass through the object; (b) light may be absorbed; or (c) light may bounce off the object.

You cannot see through an opaque object. However, it is easy to see an opaque object because it scatters sufficient light. A bright looking object throws back more light than a dull looking object, while a dull object absorbs

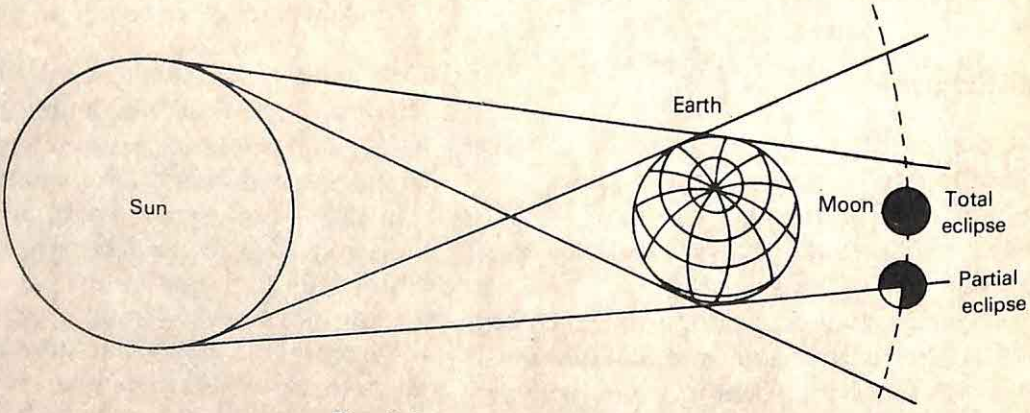


Fig. 8.8 Lunar eclipse

more light than a bright object. Transparent objects such as air and clean window panes cannot be seen because they do not throw back much light towards you. However, you can see right through such materials as they allow light to pass through them. Thus, transmission, absorption or reflection appear to be a property of the objects upon which light falls.

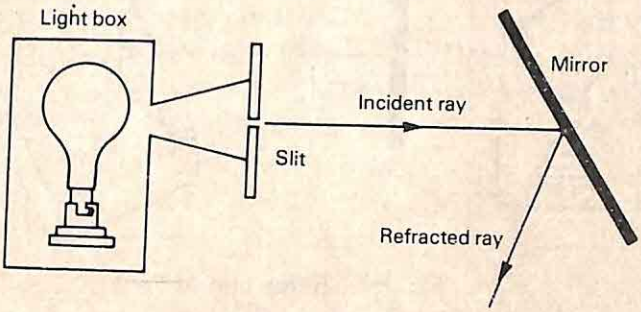


Fig. 8.9 Reflection

Experiment 5. Spread a white sheet of paper on top of a table in a dark room and place a light box at one end of the sheet. When light is switched on, you will notice the path of beam of light made visible as it grazes along the sheet. Hold a narrow vertical slit in front of the beam so that a narrow beam of light is obtained (Fig. 8.9). If you now hold a strip of mirror vertically to obstruct the beam of light you will observe that the direction of the beam is changed by the mirror.

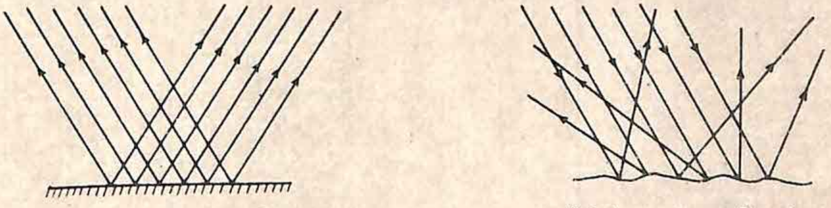
The path along which a ray of light travels up to the mirror is called an **incident ray**. *The path along which the light travels away from the mirror is called the* **reflected ray**.

Keep the mirror at various angles and notice how this changes the direction in which the reflected ray travels. Can you reflect the ray at a right angle to the incident ray? Can you reflect the ray back along its path? In every case you will observe that the reflected beam is not scattered all around but the whole of it bounces away in a particular direction. The direction depends upon how the mirror is placed (Fig. 8.10a). This is called **regular reflection** of light.

If the plane mirror is replaced by a metal sheet, you will not see a reflected beam. In this case the incident light is scattered in all directions (Fig. 8.10b). This diffused or irregular reflection is entirely due to the unevenness of the surface on which light falls. It is known as **irregular reflection** of light. We can feel the roughness of the surface, or see it by holding the metal sheet below a magnifying glass.

8.8 Refraction

We have seen earlier that light travels in a straight line through air. When obstructed by



(a) Regular reflection

(b) Irregular reflection

Fig. 8.10

various objects, it is absorbed, reflected back or transmitted through the object. When a beam or a ray of light passes through a transparent material, such as glass or water, what path does it take?

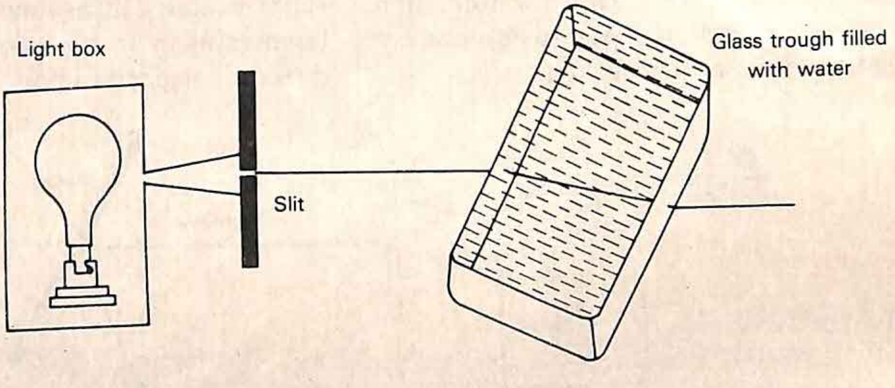


Fig. 8.11 Refraction of light

Experiment 6. Adjust the light box, with a narrow slit in front of it, on a white sheet of paper so that a narrow and bright beam of light is obtained along the paper. Darken the room and hold a rectangular glass trough filled with water in the path of the beam. Add to the water a few drops of milk or preferably a pinch of a chemical called 'fluorescein'. Look at the trough from the top.

You will notice that the beam bends away from its path as it enters the container. However, it follows a straight-line path in the water (Fig. 8.11). This bending of light as it goes from one transparent medium to another is called **refraction.** You will notice that the light is refracted a second time as it comes out of the container. Bending by refraction takes place at the two surfaces of separation.

Effects of Refraction at Plane Surfaces

Light rays suffer change of direction while going from one medium into another. Because of this it appears to us that objects, when viewed through transparent materials, are in different positions than where they actually are. In other words we see the images of these objects.

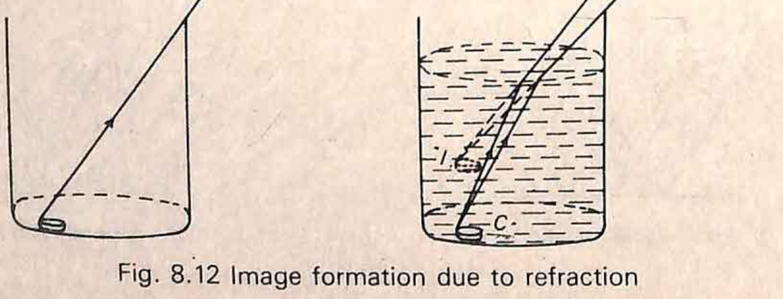


Fig. 8.12 Image formation due to refraction

Experiment 7. Take an opaque container and place a coin at its bottom. Now position yourself such that the coin is not visible, and is just obstructed by the container (Fig. 8.12). Now ask someone to gradually fill water in the container without disturbing the coin. You will observe that as the water level rises, the coin appears in sight.

As Fig. 8.12 shows, light from the coin is refracted as it comes out of the water and reaches our eyes; as a result the rays appear to come from an image *I* of the coin. The coin at *C* appears to be at *I* giving us the impression that the water is shallower than what it actually is.

Experiment 8. Fill a glass trough with water and dip a rod in it obliquely (i.e. not perpendicular to the surface of water). Look at the rod from the side through the trough, or from the top. It appears to be bent at the surface of water (Fig. 8.13).

Rays of light coming from the various points of the dipped part of the rod refract as they emerge from water into air. Thus light from each point on the dipped part of the rod has a corresponding image point. The rod therefore appears bent at the surface to our eyes.

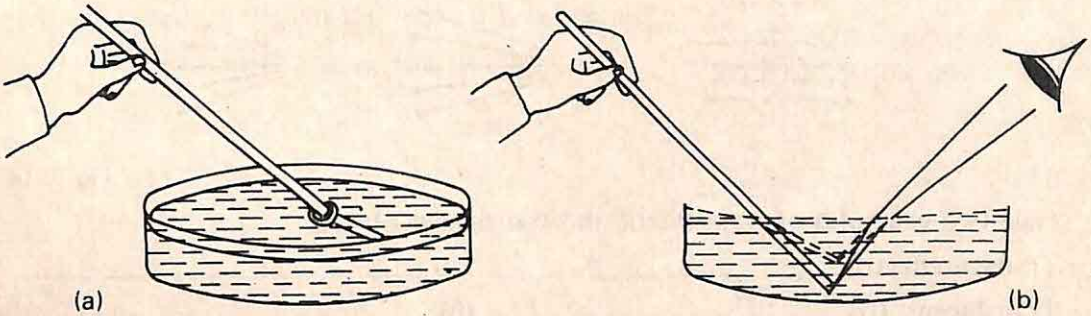


Fig. 8.13 Rod appears bent due to refraction

EXERCISES

1. Fill in the blanks with one word.
   - (a) A substance through which light can pass partially is called __________.
   - (b) An opaque object is seen by the light it__________to the eyes.
   - (c) Light travels in __________ __________.
   - (d) Objects which give off their own light are called __________ objects.
   - (e) A mirror whose reflecting surface is flat is called a __________ mirror.
   - (f) The stars are__________objects. The moon is a __________ object.

2. What is the difference between a transparent and an opaque object? ____________

____

____

3. Name two phenomenon which take place in nature and are based upon rectilinear propagation of light. ____________

4. What do you mean by a ray of light? ____________

____

5. A beam of light can be (i)____________(ii) ____________ or (iii) ____________ .

In the diagram given below label the three kinds of beams.

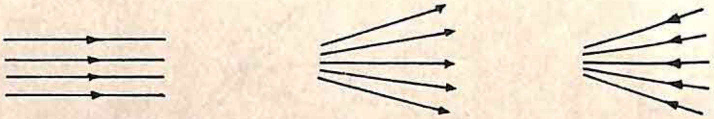


Fig. 8.14

6. Give two examples of transparent and translucent objects.

Transparent: (i)____________(ii) ____________

Translucent: (i)____________(ii) ____________

7. Complete the diagram given below and show the regions of partial and total darkness formed on the screen.

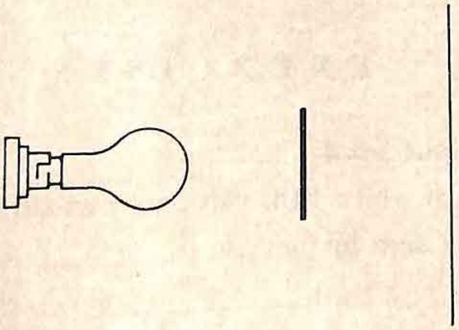


Fig. 8.15

Give names for

(i) the region of total darkness ____________

(ii) the region of partial darkness ____________

8. The diagram given below shows the formation of an eclipse.

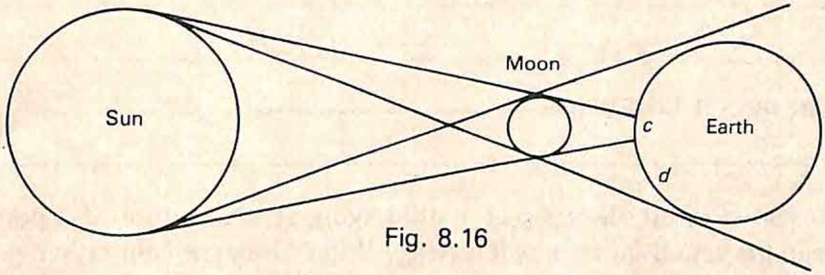


Fig. 8.16

(i) Eclipse is based upon a certain principle. Name it. ____________________

(ii) What kind of eclipse is it? ____________________

(iii) On which particular day does it take place? ____________________

(iv) Draw diagrams to show how the Sun/Moon will look like at the places *c* and *d*.

9. (i) On which particular day does a lunar eclipse take place? ____________________

(ii) When do you see a partial lunar eclipse? ____________________

____

____

10. What is the difference between regular and irregular reflection? ____________________

____

____

____

11. When does a ray of light after reflection retrace its own path? ____________________

____

____

12. (a) What is refraction? ____________________

(b) Where does it take place?

13. Fig. 8.17 shows a boy looking at a stone lying at the bottom of a pond. Does he see the stone in the actual spot where it is lying? Why? Draw the light rays to prove your point.

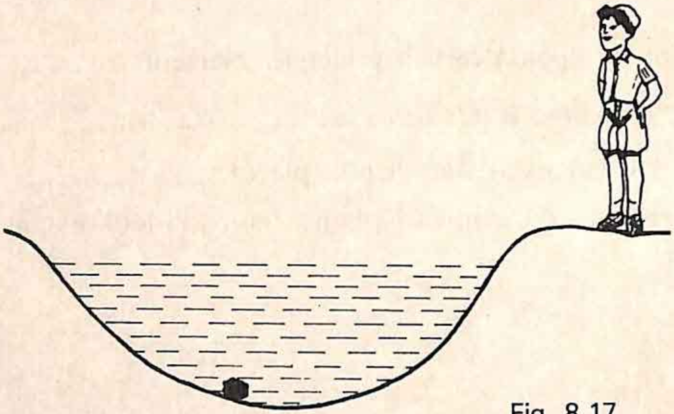


Fig. 8.17

9

Biology and Life

Rivers, lakes, glaciers, oceans, forests, mountains, valleys, deserts and ice lands are all parts of the wonderful Earth on which you live. They make our Earth a beautiful place to live in and share with others. Who are these others? Perhaps your answer will be—our parents, brothers, sisters, relatives, and friends. No, your answer is incomplete. 'Others' also include different kinds of animals and plants. **Men, birds, lizards, snakes, frogs, fishes, snails, mosquitoes, earthworms, wheat plants, mango trees, rose plants, pine trees, mosses, ferns, bacteria, etc. are all living organisms. They all have life. Can you name some other living organisms?**

Living organisms are all around us. They are in the fields, gardens, forests, mountains, deserts, caves, oceans, rivers, ponds, frozen poles and in the air around us. In fact they are everywhere on this Earth.

Some living organisms are of immense use to us while there are others which are very harmful. Still others, even though of no use to us, do not cause any harm. Can you name any five living organisms in each of these three groups?

Some living organisms are very large. A redwood tree is about 90 metres high and a blue whale is about 30 metres long. Some of the living organisms such as *Amoeba* and bacteria are so small that you can only see them with a microscope. Do you know that there are living organisms which:

(a) are green in colour,
(b) can live on land as well as in water,
(c) can live on the surface of the body of another living organism,
(d) can live inside the body of another living organism,
(e) can move freely,
(f) can fly,
(g) can climb on some supports.
(h) eat plants only,
(i) eat other animals only,
(j) eat both plants and animals,
(k) can make their own food,
(l) always eat food made by other living organisms,
(m) can build their own houses and nests,
(n) can live for more than hundred years,
(o) live only for about 24 hours,
(p) live at the same place throughout their life,
(q) migrate to other places when it is extremely cold.

Can you name any two living organisms that belong to each of the above types?

Biology is the study of all living organisms. It is the study of all the animals and plants; how they live and grow; how they can be more useful to mankind for giving him food, clothes, shelter and fuel; how their quality can be improved; how they harm us, by causing diseases and damaging our crops; how we can protect ourselves and our crops against their attacks and harmful effects, etc. The study of biology is very important in all walks of man's life.

All living organisms are always well adjusted to the surroundings or environments in which they live. Therefore, the study of living organisms is always incomplete without a study of their environments, i.e. their natural place of living. The combined study of the living organisms and the natural environments in which they live is known as **nature study.**

9.1 Living, Non-living and Dead

There are hundreds of objects which you see in your day to day life. It will not be difficult for you to record the names of *all* the objects you can see at the time when you are going through these lines. In case you happen to be in your classroom, this list will include: your teacher, books, pen, blackboard, chalk, duster, etc. Your keen observation will enable you to list some insects or perhaps a wall lizard too.

Can you group all these objects under the headings of living and non-living objects? Certainly, it will be easy. Under which heading have you listed the clothes, wooden furniture and books? It will not be correct to group them under non-living objects since these were obtained from plants which had been alive once and have since died. These should be grouped as **dead objects.** Other objects such as glass panes, chalks, etc. have never been alive and therefore these are non-living objects.

9.2 Characteristics of Living Organisms

How do you distinguish living organisms from non-living and dead objects? How will you find out whether a butterfly sitting quietly on a flower is alive or dead? How do you determine whether the plant on whose flower the butterfly is sitting is alive or dead? All living organisms have certain common characteristics or properties with which they can be distinguished from non-living and dead objects. We will now study these characteristics.

1. Form and Size

Living organisms have a characteristic form and size. For example, an animal such as mosquito, or a plant such as mushroom are small and have a typical form; an elephant is a huge being and has a trunk (Fig. 9.1a). On the other hand, non-living objects, for example air or water, have no definite size or shape.

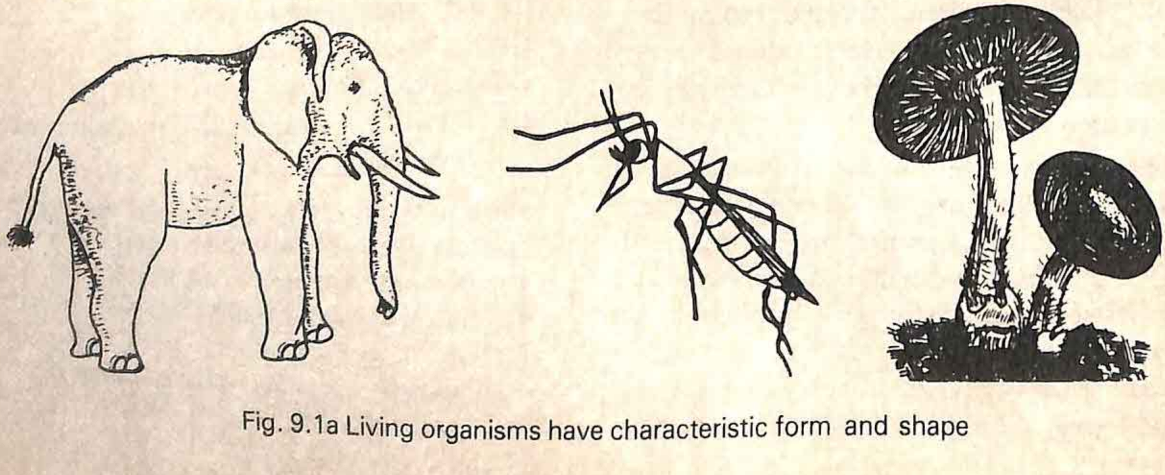


Fig. 9.1a Living organisms have characteristic form and shape

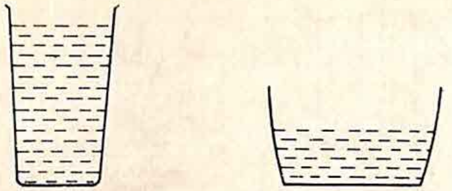


Fig. 9.1b Non-living objects do not have definite size or shape

Their shape is determined by the container in which they are taken (Fig. 9.1b), and the size depends on their quantity taken.

2. Chemical Composition

All living and non-living substances are composed of non-living elements such as carbon, oxygen, hydrogen, etc. In living substances, their combinations are in definite ratios. A non-living substance such as air contains these elements in no fixed ratio; water may have all types of impurities in various ratios.

3. Cellular Structure

You must have noticed stacks of bricks at all sites where construction of a building has to begin or the same is in progress. One cannot think of the construction of a building without bricks (or stones, as in hills). Just as a building is made up of bricks, all living organisms are made up of cells.

If we examine a thin slice of any part of an animal or a plant under a microscope, we will be able to observe many small and distinct compartments or units separated from one another by partitions. Each such microscopic unit is known as a **cell.** Fig. 9.2 shows the arrangement of cells in an onion peel. How does this arrangement of cells differ from that in the wall of a building? Like the bricks, cells are the building blocks of all animal and plant bodies. The cells are too small to be seen without a microscope. However, with their large numbers, they form structures and organs of living organisms. A living cell always contains the living substance called **protoplasm**. The protoplasm is differentiated into **nucleus** and **cytoplasm**. Protoplasm performs all the important functions of a cell. Chemically, protoplasm is a highly complex mixture of a large number of chemical substances of which proteins are the chief. To bring about the functions of life in a cell, chemical reactions take place in the cells at all times. This is known as **metabolism.**

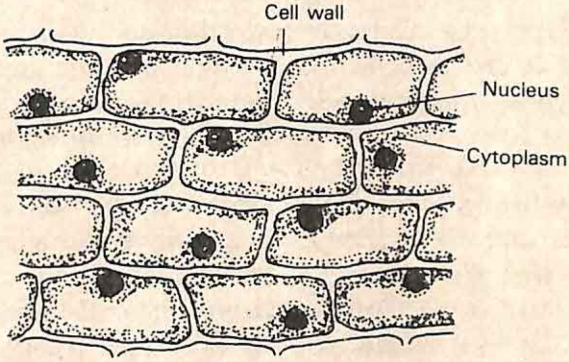


Fig. 9.2 Cells from an onion peel

Just as a bigger building is made up of more bricks and a smaller one of lesser bricks, a larger animal like an elephant and a larger plant like a mango tree have more cells than a smaller animal like a mosquito and a smaller plant like a pea plant. Some living organisms like bacteria and *Amoeba*, etc. are unicellular and have a single cell in their bodies. Others like man and a mango tree are multicellular and have many thousands of cells in their bodies.

4. Movement

Movement is one of the most important signs of life. Most of the animals move about freely from place to place. However, the movement in plants is quite restricted and slow.

Primarily, animals have to move from place to place to find their food. Plants, on the other hand, do not need to move from place to place. The materials such as water, air and mineral salts which they require for their growth are usually available where they grow. Besides moving about to find food, the animals also move to escape from their enemies and to find shelter. In addition to this, the animals can move many parts of their body. For example, a cow moves its tail to ward off flies and an elephant moves its trunk for feeding. We can also move many parts of our body according to our wish, e.g. our legs for walking and running, or fingers to hold something.

Experiment 1. Leave a small potted plant, a wide mouthed jar with a living snail in it and a toy cart on a table. Place the table near a window so that all the things receive sunlight (Fig. 9.3). Keep observing the movements in all the three for a week. Does the plant show any movement? Is the living snail at the same position? Does the toy cart move?

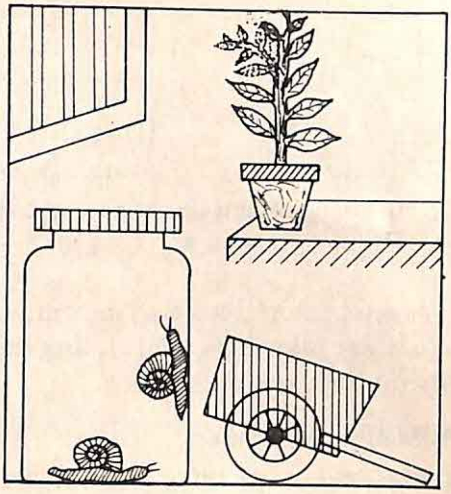


Fig. 9.3 Movement in living and non-living things

Since plants usually remain fixed in the soil, movement in plants is restricted to certain parts only, such as the opening and closing of petals, or to the movement of the parts as a result of growth. The roots grow and move deeper into the soil to obtain water and soluble mineral salts. In a germinating seed, the young shoot always grows towards light. The leaves of touch-me-not plant close up and droop down when they are touched (Fig. 9.4). Similarly, leaves of some plants show sleep movements They close up in the evening and open again in the morning.

Non-living objects do not, however, move on their own. They move only when they are moved with the help of an outside force. A boulder shifts only when it is pushed, machines work and automobiles move with the help of

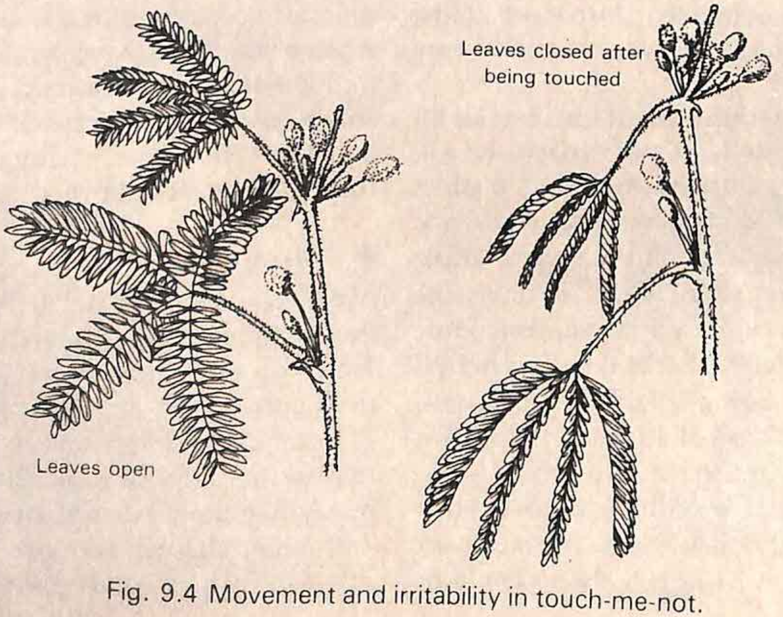
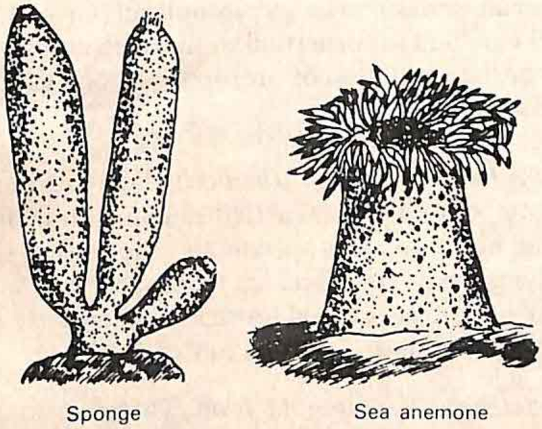
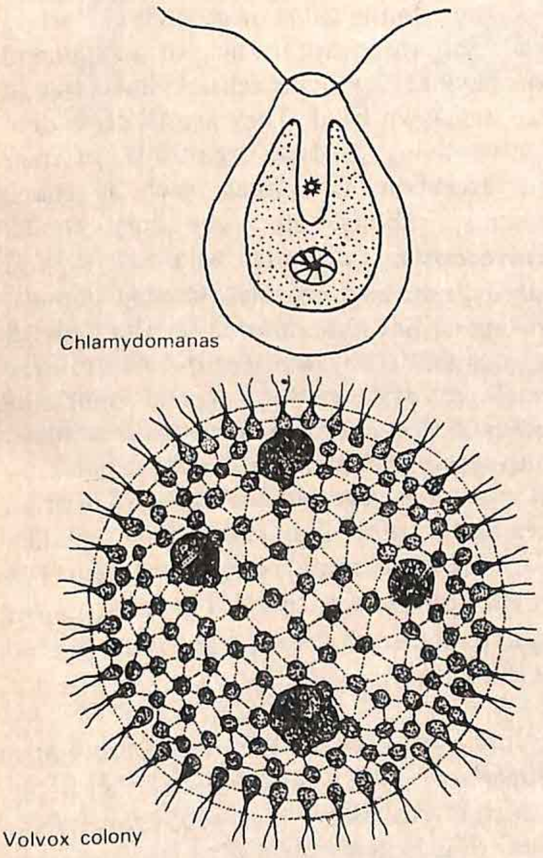


Fig. 9.4 Movement and irritability in touch-me-not.

energy which they obtain from fuels such as petrol, diesel, coal, electricity, etc.



(a) Animals that do not move



(b) Plants that move freely

Fig. 9.5

However, there are examples of animals which always remain fixed at one place and of plants which move about freely. Sponges and sea anemones are animals which remain fixed to rocks, and volvox, chalmydomonas, etc. are plants which swim about freely in water (Fig. 9.5).

5. *Irritability or Sensitivity*

How does a butterfly sitting on a flower react when you go near it for catching it? How does your pet dog react when you call it? How do you react when a stray dog barks at you? Have you ever touched the leaves of a touch-me-not (*Minosa pudica*) plant?

Experiment 2. Leave a healthy potted plant and a dried up and dead potted plant near a window. Sunlight will fall directly only on that side of each plant which faces the window. The other side of each plant will not receive any direct light. Keep on watering each plant. After about a week, you will observe that the stem of the healthy potted plant curves and grows towards the side from which sunlight falls on it. You will not observe any growth or movement in the dead plant (Fig. 9.6).

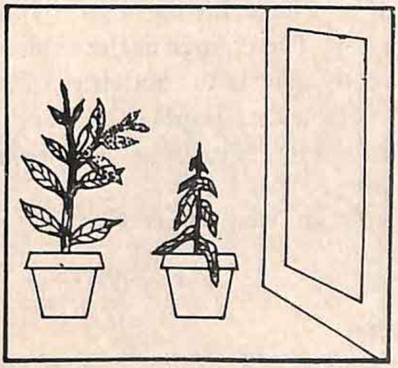


Fig. 9.6 A living plant bends towards sunlight

Experiment 3. Place some wet toffees in a plate kept in the open. Leave the plate undisturbed for about half an hour. The wet toffees attract ants and flies from the surroundings (Fig. 9.7).

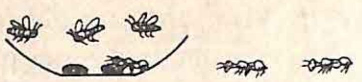


Fig. 9.7 Food attracts living things

Will some non-living and dead objects lying in the surroundings also be attracted by the wet toffees?

Experiment 4. Make one of your friends stand near the blackboard in such a way that his back is towards the blackboard. Take a piece of chalk in your hands, and suddenly move your hand as if you were going to throw the chalk in the direction of your friend. How does your friend react? Does the blackboard show any reaction also?

In all the above experiments we notice that living things respond to changes in the environment. The plant responds to sunlight coming from one direction only, by bending towards it. Ants and flies respond to the toffees. Your friend responds to the sudden danger of a chalk hitting him by quickly moving away. The change in the environment which directly affects the activities of a living organism is called a **stimulus.** *All living things respond to stimuli because of their* **sensitivity** *or* **irritability.**

Non-living and dead objects do not respond to stimuli.

6. Nutrition

Food in sufficient quantity, and of the right and suitable kind is the foremost requirement of all living organisms. Living organisms require food for the following reasons.

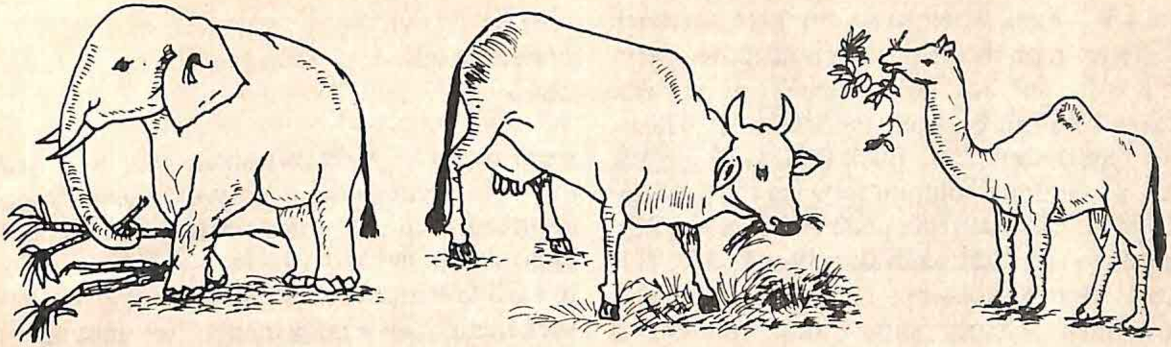
(i) *To provide energy:* For all our daily activities such as walking, writing, playing, breathing, etc. we need energy. This is provided by food. If a person does not eat he will become weaker and will ultimately die. Food provides us with energy in the same way as petrol provides energy to a car.

(ii) *For the growth of the body:* You have all seen small plants and animals growing bigger. The living substance within the cells of all living organisms is known as **protoplasm.** Growth is always due to formation of more protoplasm. For the formation of protoplasm, food is very essential.

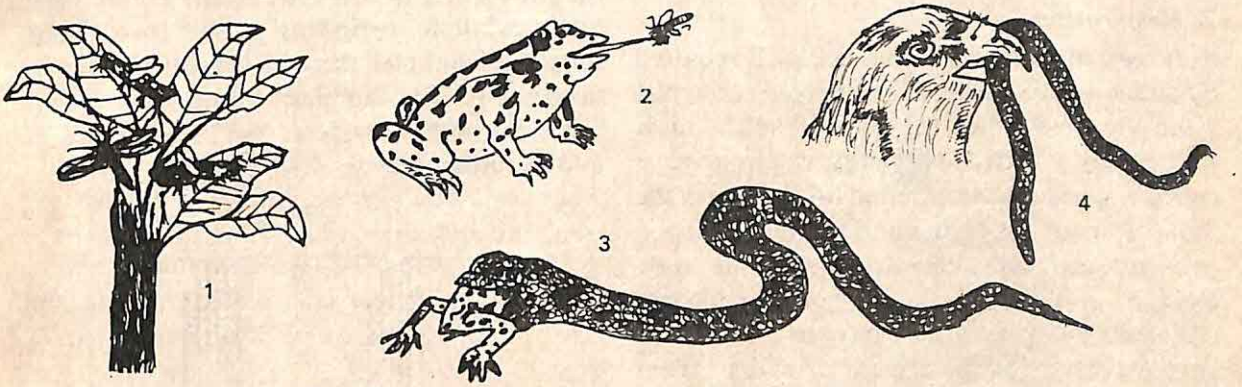
(iii) *For the repair of the body:* Due to a large number of chemical activities going on within the body, the protoplasm and the cells in the living body are subjected to a lot of wear and tear. Food is essential for repairing or replacing the protoplasm in worn out cells.

Methods of obtaining food: Different living organisms have different methods of obtaining their food. Green plants can make their own food from simple substances such as carbon dioxide and water with the help of sunlight and chlorophyll in their living cells. Animals cannot make their own food. They are all dependent on other living or dead organisms for their food. **Herbivorous** animals such as goats, elephants, rabbits, etc., eat only plants. **Carnivorous** animals such as lions, wolves, leopards, etc. are only flesh-eating animals. **Scavengers,** like the vulture, eat the flesh of dead animals. They wait for old and injured animals to die, or they depend upon the remains of the kill of the carnivorous animals. **Omnivorous** animals, like man, eat plants as well as animals. **Parasitic** animals live in or on the bodies of other living animals and plants, and obtain their food directly from them. For example, tapeworms live in the intestines of man and rat-fleas live on the body of a rat and suck its blood.

The food chain: Green plants are also called the **producers.** They supply food to all living organisms. Animals which feed directly on plants (Fig. 9.8a) are called the **primary consumers,** e.g. when a goat feeds on plants, goat is a primary consumer and the plants are



(a) How animals depend on plants—directly



(b) How animals depend on plants—indirectly

Fig. 9.8

the producers. Goats' meat is eaten by man, who is the **secondary consumer.** Man, therefore, depends upon grass indirectly (Fig. 9.8b). Large carnivorous animals such as the lion, feed on other animals such as zebra, cow, etc. which themselves feed on grass. This kind of relationship is known as a **food chain.**

You will notice that the sequence in a food chain always starts with green plants. The food which the plants manufacture initially is a simple sugar like **glucose** which is immediately changed into **starch.**

Experiment 5: To test for the presence of starch in leaves. Select two healthy potted plants A and B. Place A in a dark room for 72 hours. Allow B to grow normally in sunlight.

Pluck one leaf from each of the plants A and B. Dip both the leaves in boiling water for about one minute. This will kill the leaves. Boil the leaves separately in alcohol or some other chemical that dissolves chlorophyll, until all the chlorophyll is dissolved and the leaves become non-green (see Fig. 9.9 for method of boiling the leaf in alcohol). Dip both the leaves once

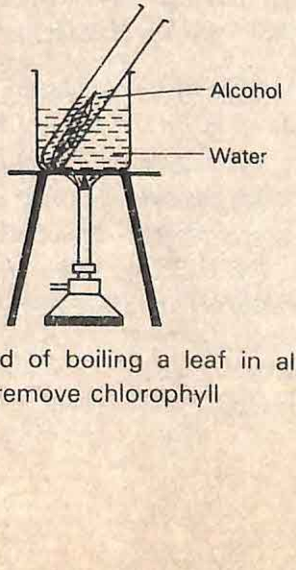


Fig. 9.9 Method of boiling a leaf in alcohol to remove chlorophyll

again in boiling water to soften them. Remove the leaves from boiling water and spread them on a white surface. Add a few drops of weak iodine solution on both the leaves. It will be seen that the leaf from plant B turns blue-black with weak iodine solution showing the presence of starch. The leaf from plant A which was kept in a dark room does not turn blue-black. This shows that it does not contain starch. This experiment clearly shows that sunlight is necessary for the plants to manufacture food.

7. *Respiration*

You have already learnt that energy is required by all living organisms. This energy is obtained from the food which they take. The chemical process by which this energy is obtained is called **respiration.** Respiration takes place in the living cells of all plants and animals. During respiration, food is chemically acted upon by oxygen, and energy and carbon dioxide are released. The presence of oxygen is therefore very essential for the release of energy from food.

In all animals as well as plants, respiration consists of:

(i) breathing in oxygen from the environment,
(ii) chemical action of oxygen on the food in the living cells and the release of energy, and
(iii) breathing out of carbon dioxide formed in the living cells by the chemical action of oxygen on the food.

Breathing in of oxygen and breathing out of carbon dioxide is carried out in different ways in different living beings. Men, dogs, cats, etc. have organs known as **lungs** for breathing. Fishes breathe through **gills** and the earthworm through the skin. Plants have small holes known as **stomata** in the leaves for this purpose.

Breathing is an essential sign of life. You may have observed that the first thing that a doctor does to examine an accident victim is to check whether the victim is breathing or not. The victim is declared dead only if the breathing is stopped.

Experiment 6: To demonstrate that breathed out air contains more carbon dioxide than breathed in air. The apparatus should be set up as shown in Fig.9.10. Place fresh lime water in each test tube. Place your mouth at X, and suck in air. The arrangement of the glass tubes is such that on breathing in, air bubbles through the lime water in test tube A and enters your lungs, while on breathing out air leaves your lungs and bubbles through the lime water in test tube B. The samples of lime water in test tubes A and B, therefore, test the breathed in and breathed out air respectively.

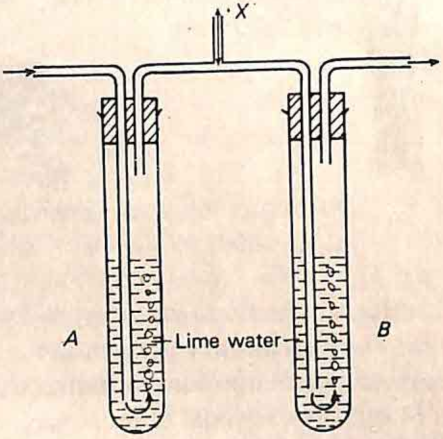


Fig. 9.10 To show that breathed out air contains more carbon dioxide than breathed in air

After having breathed air in and out of the apparatus for about 2 minutes, what do you observe about the lime water in the two test-tubes? The lime water in tube B becomes milky while that in tube A remains almost clear. This shows that air passing through tube B (breathed out air) has more carbon dioxide than the air passing through tube A (breathed in air).

8. *Excretion*

Carbon dioxide formed in the living cells during the process of respiration is a harmful waste substance. It cannot be allowed to collect in the living cells otherwise it will harm the cells. Like carbon dioxide, there are other harmful and waste substances, which are formed in the living cells during chemical reactions. Some of these substances are urea, uric acid, etc. in the cells of animals, and tannins, resins, gums, etc. in the cells of plants. Since they are all harmful and lead to malfunctioning of living cells, the living organism must get rid of them. The process by which a living organism throws out from its body all the waste and harmful substances formed during the chemical reactions is known as **excretion.**

Animals have special organs such as kidneys, sweat glands, lungs, gills, etc. for excretion.

Plants do not have special organs for excretion. They throw out carbon dioxide through small holes called **stomata** in their leaves. Other wastes such as tannins, resins and gums collect in their bark or old leaves which are constantly shed off by the plants.

9. Growth

We were all born as infants. As the years go by, our limbs increase in size, our bones and muscles become stronger, our minds develop. You must have also noticed that the clothes which you wore two years ago do not fit you now. Obviously, you have grown bigger now. In your garden also, you must have noticed that only the plants which you cultivate in the pots grow and that the pots do not ever grow.

The process of becoming bigger in size is a part of the process called **growth.** All living organisms grow. Growth takes place as a result of the formation of more protoplasm in the cells. For their growth, the living organisms require food which they change into protoplasm within their cells.

Have you ever noticed any animal or plant decreasing in size as the months and years go by? Have you ever noticed any animal or plant changing its form to look similar to what it was a few years or months ago? No, never. This is because growth is always a permanent and irreversible change in form.

A non-living object can also 'grow'. For example, a crystal of copper sulphate suspended in a saturated solution of copper sulphate in water grows bigger (Fig. 9.11). But in a non-living object, the growth is by addition of material on the outside. In the living being the growth occurs from within.

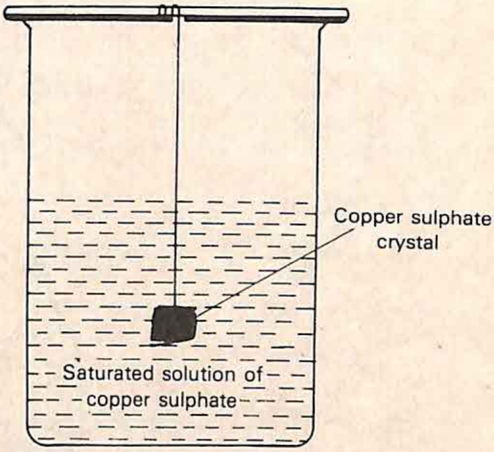


Fig. 9.11 Growth in non-living objects is by addition of material on the outside

10. Life Cycle and Reproduction

No living organism can live for ever. Every organism has to go through a life cycle of birth, growth, maturity, old age and death. A pea plant is formed as a seedling when a pea seed germinates. The seedling grows into a plant which bears flowers, fruits and seeds. In a few months, although the pea plant dies, its form, features and life are passed on into pea seeds, which will develop into new pea plants. The pea seeds will *always* grow into pea plants and never into wheat plants or rice plants or any other plants. Surely, you have never seen mangoes growing on a guava tree or vice versa.

Reproduction is one of the important features of all living organism. *All living*

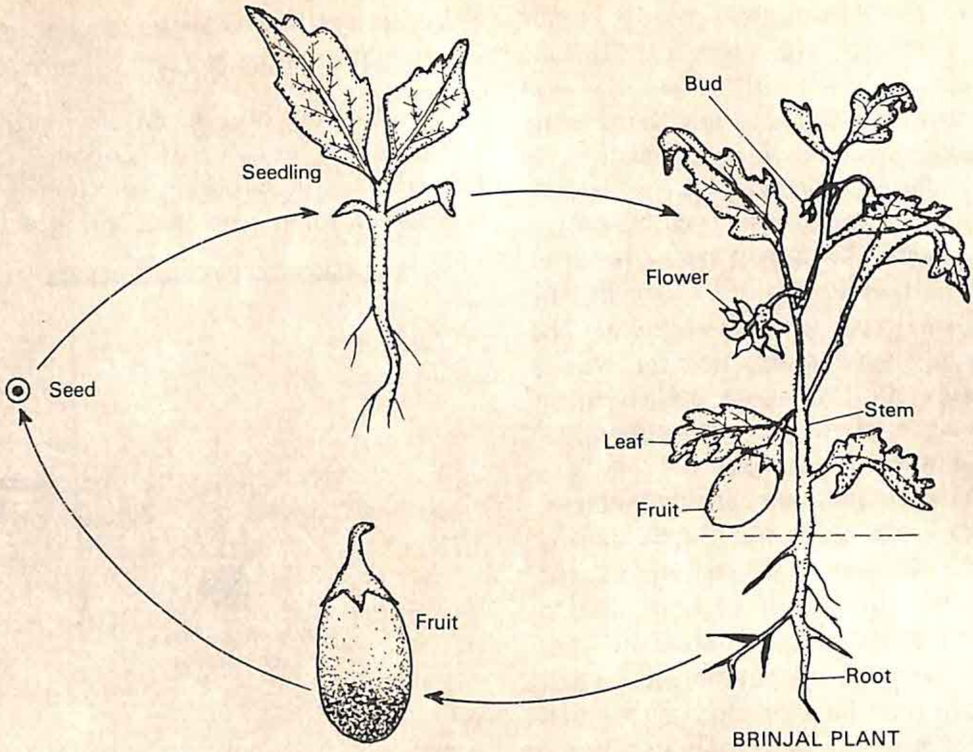


Fig. 9.12 Life cycle of brinjal plant

organisms reproduce their own kind. Like the plants, animals also reproduce. From the pigeon's eggs will always emerge a pigeon and never a rabbit or a snake or any other animal. A doe rabbit will always give birth to baby rabbits and never to any other animals.

EXERCISES

1. (i) Distinguish between dead and non-living objects.____________________

____

____

____

(ii) Classify the following as living, non-living and dead.

wooden table________________ cotton shirt________________

nylon shirt________________ glass________________

flower________________ lead________________ mosquito__________ air__________

leather bag__________ plastic bag__________

2. Why do animals move from place to place? __________

3. (i) Why do plants not have to move about in search of food? __________

   (ii) Name a plant that moves freely and an animal that does not move. __________

4. (i) What is a stimulus? __________

   (ii) A thorn pricks your finger and you quickly move your hand away. Mention the stimulus and the response in this activity. __________

5. (i) Why do we require food? __________

   (ii) Give an example of a food chain in nature. __________

6. Explain the following.

   (i) Herbivores __________

   (ii) Carnivores __________

   (iii) Parasites __________

(iv) Producers ____________________

(v) Secondary consumers ____________________

7. (i) Which process is responsible for releasing energy from food? ____________

(ii) Which waste product is released during the process. ____________

(iii) Name the element whose presence is necessary for the process to take place. ____________

8. (i) Mention some waste products formed in the cells of

(a) animals ____________________

(b) plants ____________________

(ii) How are these excreted from their bodies? ____________________

9. How is growth in living organisms different from growth in non-living objects? ____________

10. Fill in the blanks.

(i) Growth in living things occurs due to the formation of more ____________ in the cells.

(ii) The ____________ is the largest animal.

(iii) The ____________ is the tallest tree.

(iv) The study of living organisms and their natural environment is known as ____________.

(v) The leaves of ____________ close up when they are touched.

(vi) Animals which eat plants as well as other animals are called ____________.

(vii) Animals which feed directly on plants are called ____________ consumers.

(viii) The bodies of living organisms are made up of ____________.

11. Write 'True' or 'False'.
    (i) Peas can grow on brinjal plants.
    (ii) Growth in living things is permanent and irreversible.
    (iii) Movement in plants is restricted to certain parts only.
    (iv) Green plants supply food to the entire living world.
    (v) Secondary consumers eat primary consumers.
    (vi) Plants manufacture starch which is immediately changed to glucose.
    (vii) Breathed in air contains more oxygen than breathed out air.
    (viii) Protoplasm is present in both living and non-living objects.

10

Plants around Us

Look around anywhere in your surroundings, you will always find a variety of plants. Since times immemorial, plants have fascinated man for their beauty to such an extent that he has started growing them on his roof tops and within his living rooms and offices. In fact plants have become a part and parcel of his life. If you are asked to name a few plants, you will name plants such as mango, wheat, tomato, neem, peepul and sheeshum, etc. since these are the plants which you find in your immediate surroundings. However, there are several plants which are so small that you can see them only with the help of a microscope.

Experiment 1. Take a drop of water alongwith the greenish scum which floats on the water in a stagnant pond. See it under a microscope. You will notice some green plants floating in it. These plants are called **algae** (Fig. 10.1e).

10.1 Types of Plants

There are tens of thousands of plants in this world. Some of them bear flowers while others do not.

Non-flowering Plants

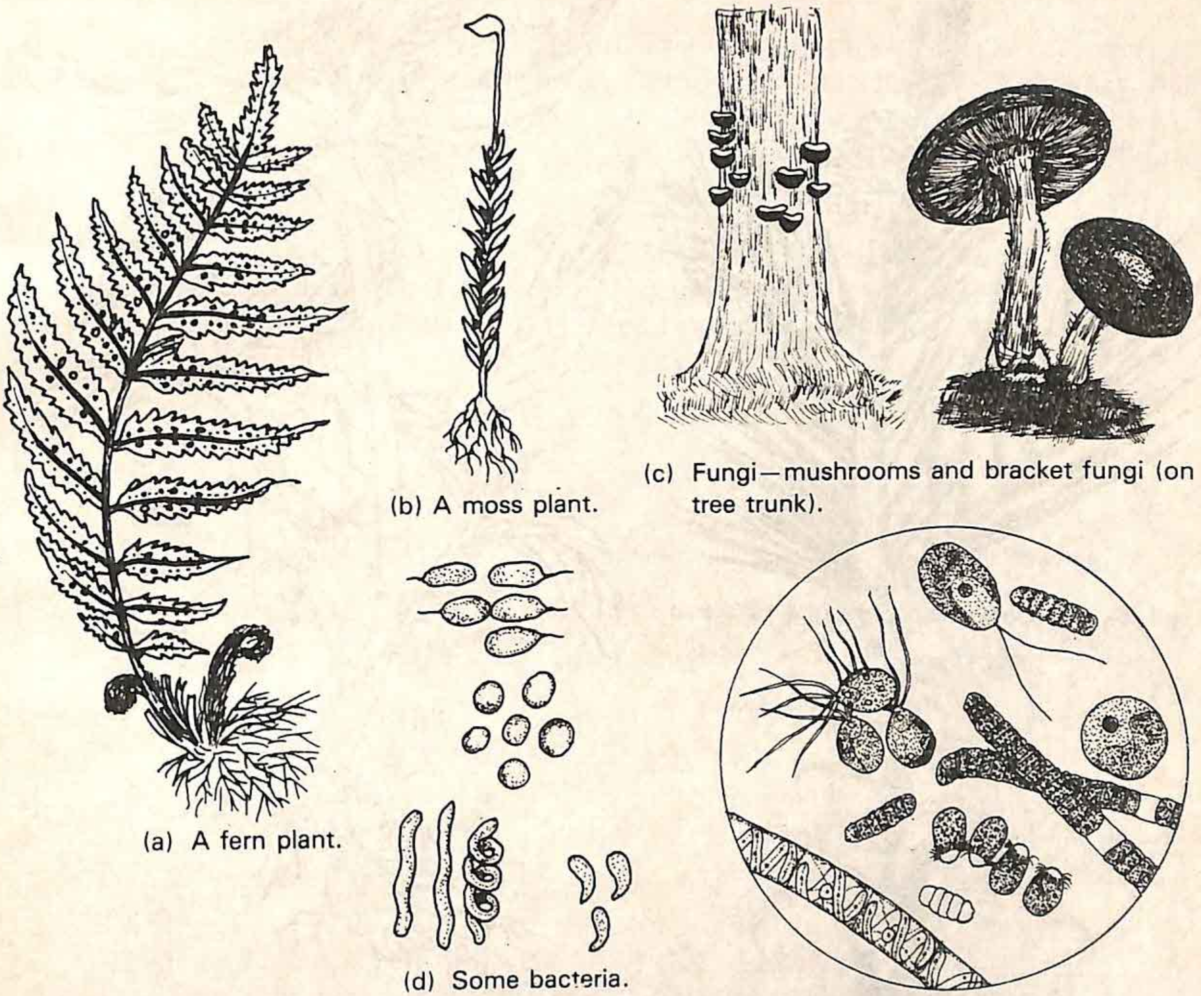
These do not bear flowers. Some of these are large enough to be seen without a microscope while others are so small that they can be seen with the help of a microscope only. Examples of non-flowering plants are as follows.

(i) *Ferns* (Fig. 10.1a): They grow in cool, moist and shady places, both in the hills and the plains. Some of them grow even on tree trunks.

(ii) *Mosses* (Fig. 10.1b): They grow on damp walls, wet ground and moist tree trunks during the rainy season. They form green patches of soft velvet-like carpets. A moss plant grows to about 2.5 cm in height.

(iii) *Fungi* (Fig. 10.1c): These are non-green plants. They cannot make their own food. They obtain their food from other living organisms or dead and decaying animals or plants. Some of them cause diseases of plants and animals. Examples of fungi are moulds, mushrooms and bracket fungi.

(iv) *Bacteria* (Fig. 10.1d): These are also non-green plants. Their bodies are made of a single cell only. Like fungi, they also obtain their food from other living organisms or dead and decaying matter. Some of them cause diseases



(a) A fern plant.

(b) A moss plant.

(c) Fungi—mushrooms and bracket fungi (on tree trunk).

(d) Some bacteria.

(e) Some algae—as seen in a drop of stagnant water through a microscope.

Fig. 10.1 Some non-flowering plants

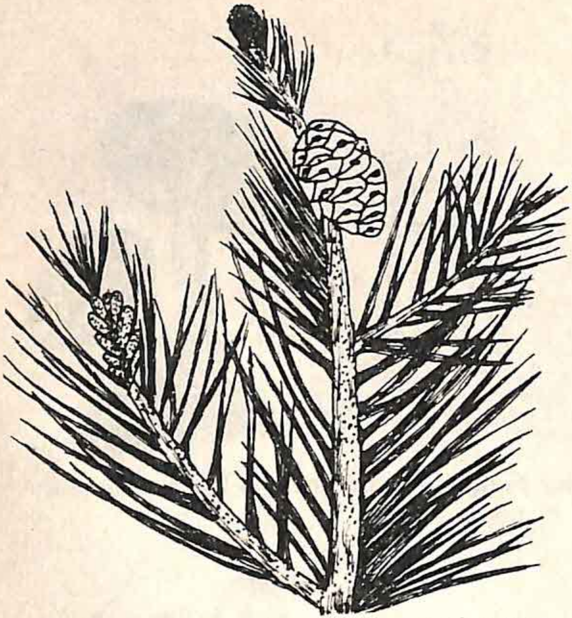
of plants and animals. For example the bacteria *Vibrio cholerae* causes cholera.

(v) *Algae* (Fig. 10.1e): These are mostly green plants which can make their own food. They grow in large numbers in water in very wet places. Some of them for example *Chlamydomanas* can be seen only with the help of a microscope. Some larger types grow in the sea and are called sea weeds.

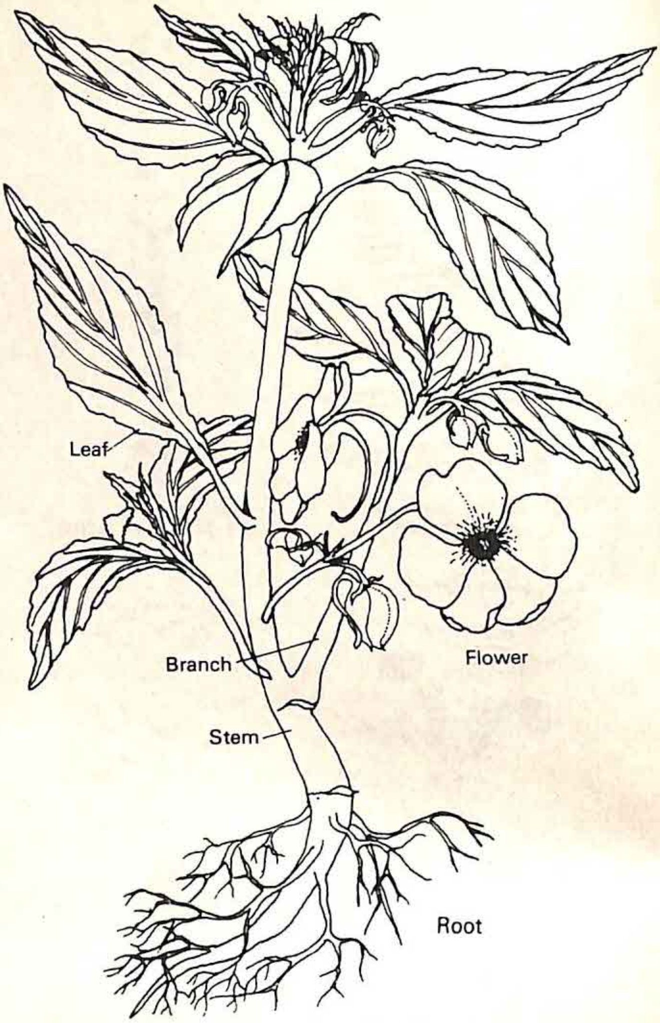
Flowering Plants

These bear flowers and seeds for reproduction. Most of the plants you see every day are of this type. There are two types of flowering plants.

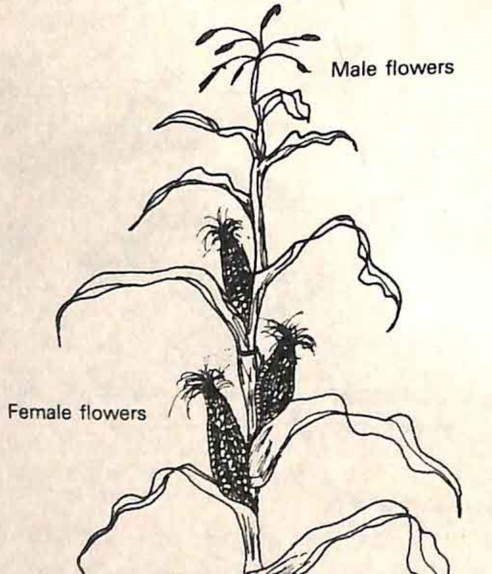
(i) *Gymnosperms* (Fig. 10.2a): In these plants the seeds are not enclosed in fruit and there are separate male and female flowers. The pine tree is a gymnosperm.



(a) Gymnosperm—branches of a pine tree



(b) Angiosperm—balsam, a dicotyledonous plant



(c) Angiosperm—maize, a monocotyledonous plant

Fig. 10.2 Some flowering plants

(ii) *Angiosperms* : In these plants, the seeds are enclosed in the fruit. Some plants bear separate male and female flowers while others bear flowers which have male and female reproductive parts.

There are two types of angiospermic plants.

(a) *Dicotyledonous plants* (Fig. 10.2b): In these plants, the seed has two **cotyledons** or fleshy leaves and the green leaves have a network of veins. Examples are pea, gram, mango, balsam, etc.

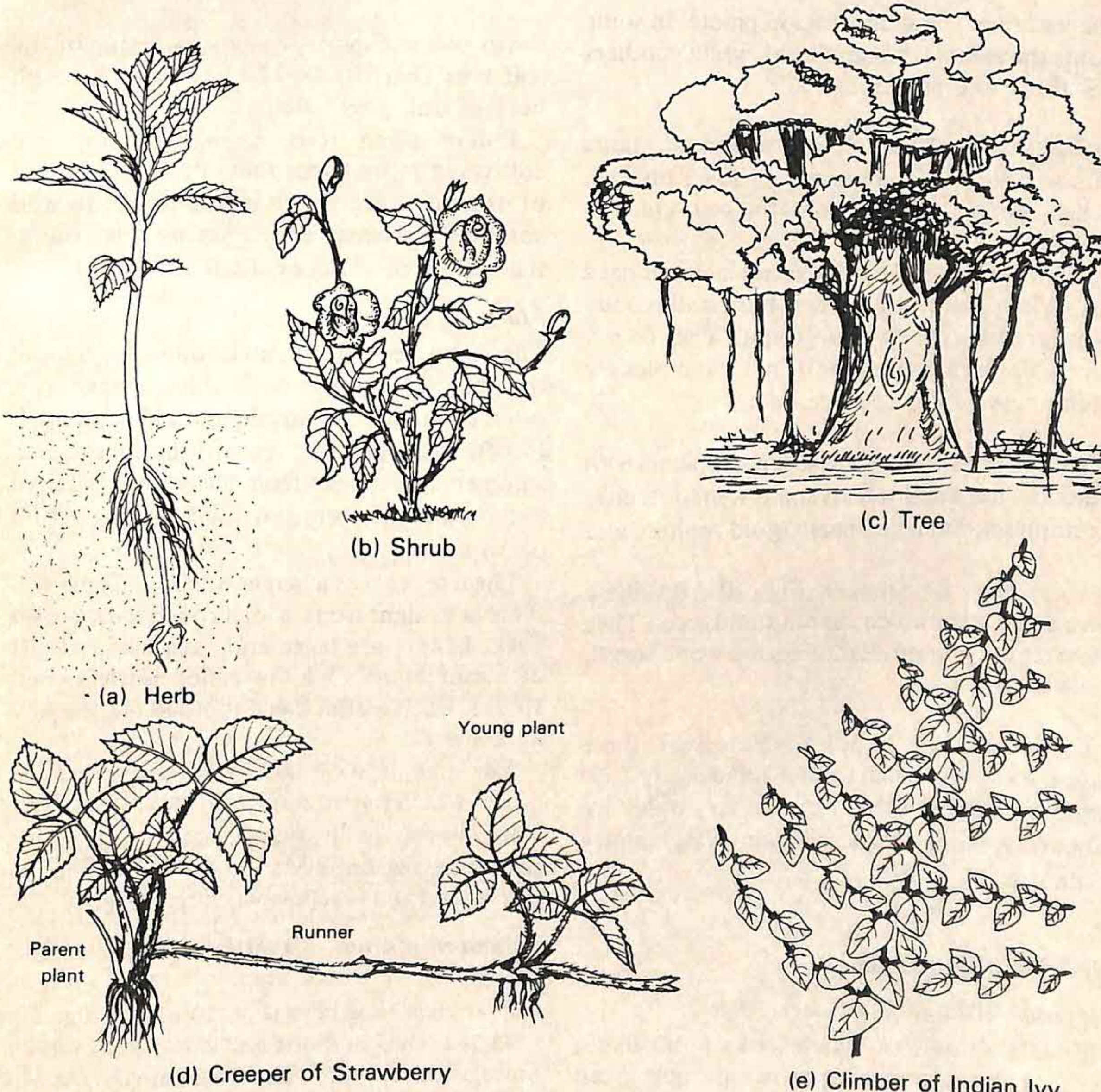
(b) *Monocotyledonous plants* (Fig. 10.2c): In these plants, the seed has only one cotyledon and the green leaves have parallel veins. Examples are wheat, maize, rice, coconut, etc.

10.2 Duration of Life

Depending upon the duration of their life cycle, there are three main types of plants.

1. *Annuals*: These plants live for a few months or at the most for one year. They grow and produce flowers and seeds within this period and then die. Examples are rice, wheat, mustard, tomato, groundnut, etc.

2. *Biennials*: These plants live for two years. They grow in the first year and produce flowers and seeds in the second year, after which they



(a) Herb

(b) Shrub

(c) Tree

(d) Creeper of Strawberry

(e) Climber of Indian Ivy

Fig. 10.3 Stems of plants

die. Examples are cabbage, beet, turnip, carrot, etc. However, in tropical climate, these plants behave like annuals.

3. *Perennials*: These plants live for more than two years—in fact for many years. Examples are mango, shoe-flower, potato, ginger, etc.

10.3 Stems of Plants

The nature of the stem varies in plants. In some plants the stem is thin and weak while in others it is thick and strong.

(i) *Herbs* (Fig. 10.3a): These are small plants with soft stems. Examples are grass, mustard, radish, ginger, potato, tomato, pea, etc.

(ii) *Shrubs* (Fig. 10.3b): These are medium sized bush-like plants with several hard and woody stems growing close to the ground. They do not have a single main stem or trunk. Examples are China rose, night jasmine, etc.

(iii) *Trees* (Fig. 10.3c): These are tall plants with a distinct hard and woody main stem or trunk. Examples are mango, neem, gold mohur, etc.

(iv) *Creepers or runners* (Fig. 10.3d): These have a soft stem which cannot stand erect. They creep on the ground. Examples are wood sorrel, strawberry, etc.

(v) *Climbers* (Fig. 10.3e): Like creepers, these have a soft stem which cannot stand erect. They climb on neighbouring objects. Examples are Indian ivy, money plant, bougainvillea, country bean, etc.

10.4 Plants around Us

Zizyphus (Indian Plum tree—*Ber*)

This is a short tree which looks more like a shrub. It has a spreading crown of light green coloured foliage leaves. Each leaf bears two sharp pointed spines, one on each side of the leaf base (Fig. 10.4). The tree bears a rough bark of dull grey colour.

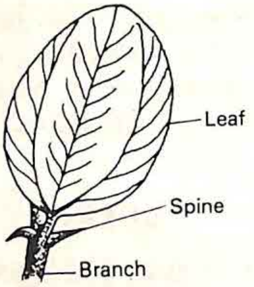


Fig. 10.4 Leaf of Indian Plum tree

Indian plum trees grow wild but are cultivated in orchards these days on account of its fruit which is rich in vitamin-C. In wild varieties, the leaves and fruits are small but in the cultivated varieties, these are larger.

Margosa (*Neem*)

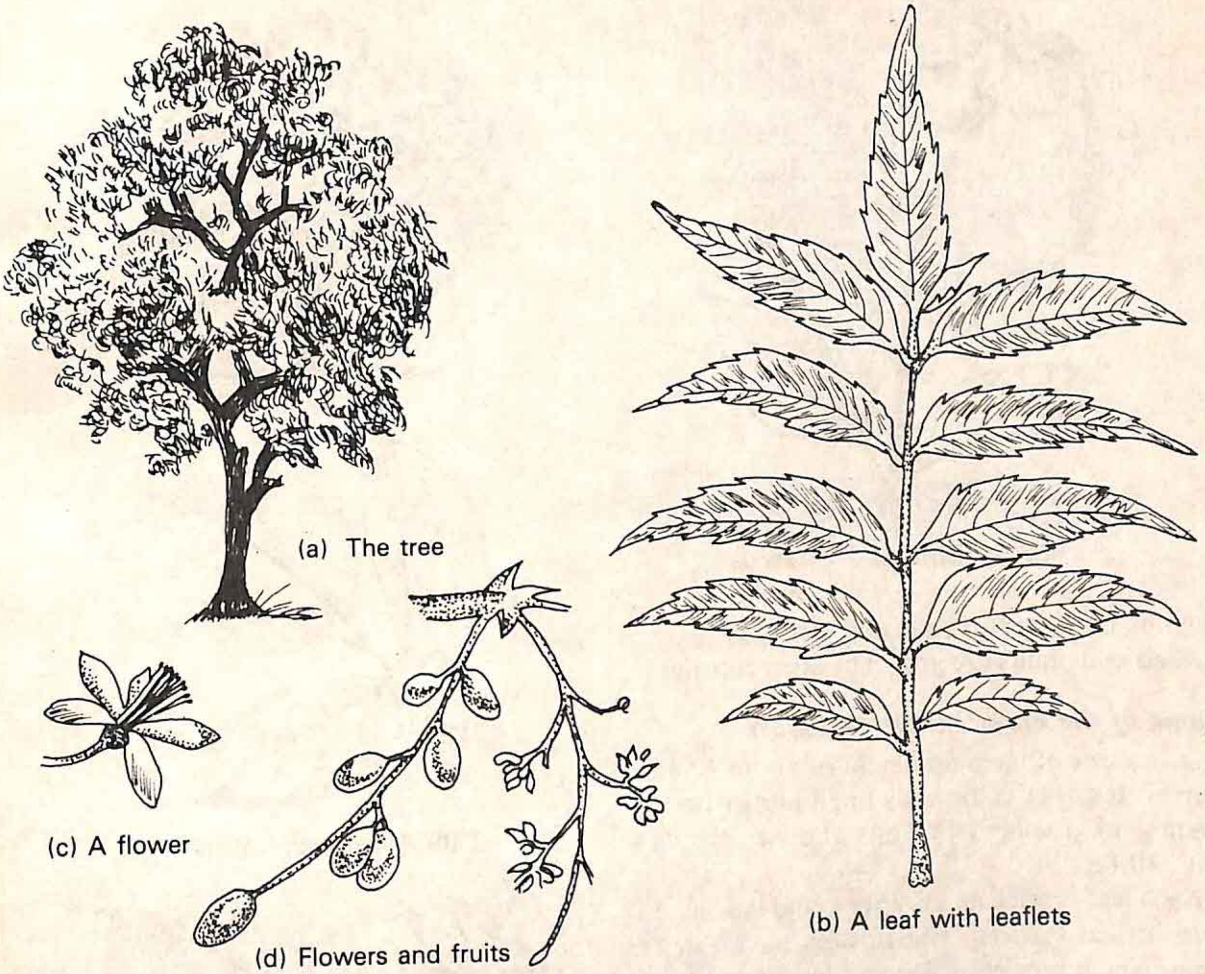
The *Neem* tree (Fig. 10.5a) is found throughout the country. Because of its thick foliage, it is often planted as a roadside tree and in villages. It offers a cool and comfortable shade in summers. An extract from its leaves is believed to have an antiseptic and quick healing action on wounds.

The tree reaches a height of about 15 metres. It has a straight trunk with a rough dark brown bark. Leaves are large and each leaf consists of about 11 to 15 lobes called **leaflets** (Fig. 10.5b). Each leaflet has a toothed margin and an acute tip.

The tree bears small white flowers (Fig. 10.5c) which have a mild and sweet fragrance. The flowers are always borne in clusters. The flowering season is March-April. The fruit is one seeded and is yellow when ripe (Fig. 10.5d).

Solanum nigrum (*Makoh* or Black Night Shade)

This is an annual herb (Fig. 10.6) which grows wild as a weed in moist and shady places in all parts of the country. The leaves are dark green in colour and each leaf is about 5-8 cm long


(a) The tree

(b) A leaf with leaflets

(c) A flower

(d) Flowers and fruits

Fig. 10.5 Parts of Margosa tree

and about 2-3 cm broad. Leaves have a toothed margin. The plant bears small white flowers in clusters and almost throughout the year. Each flower produces a small round fruit which is blackish-green in colour.

Hibiscus (China rose)

This is a perennial ornamental shrub and looks more or less like a small tree (Fig. 10.7). The stem is solid, smooth and woody. Each leaf is bright green in colour and about 8-10 cm in length.

The plant bears large and bright scarlet red coloured flowers which bloom throughout the year. The flowers are always solitary instead

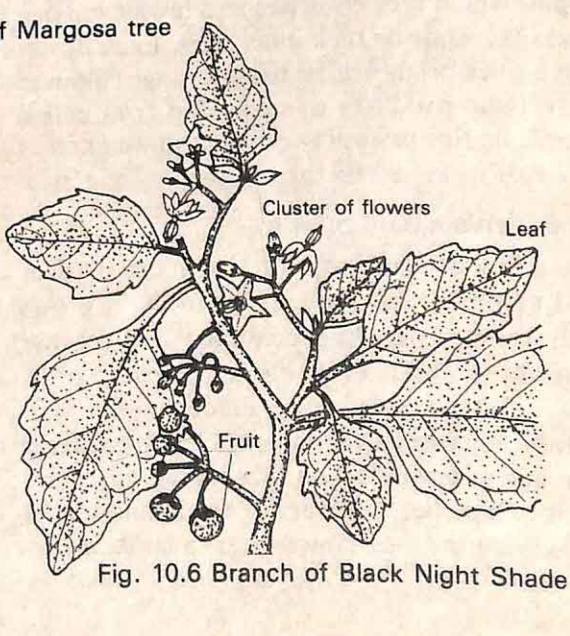


Fig. 10.6 Branch of Black Night Shade

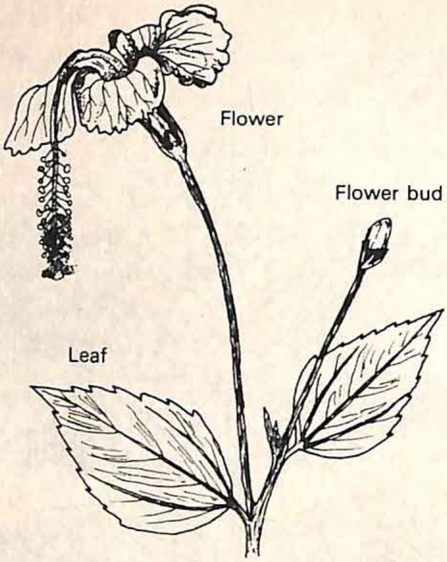


Fig. 10.7 Branch of Hibiscus

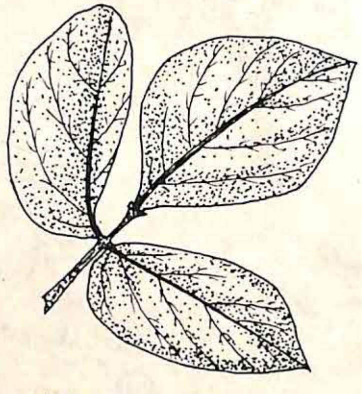
of being in clusters. Fruits and seeds are never formed and plants are grown by stem cuttings.

Flame of the Forest (*Dhak* or *Palas*)

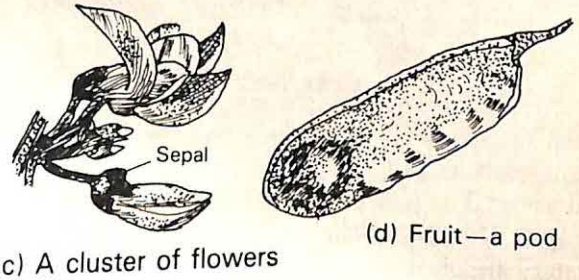
This is a tree of medium height of about 10-15 metres. It grows commonly in all parts of our country in grasslands, forests and wastelands (Fig. 10.8).

Each leaf is thick and leathery, and has three lobes called leaflets. The flowers have thick **sepals** which are velvet-like and brown outside and silky white on their inner sides. Each flower has 5 thick bright scarlet red or orange coloured petals and produces a one seeded fruit called **pod.** The ripe pods are very light in weight and are easily carried to far off places by wind.

(a) The tree



(b) A leaf with leaflets



(c) A cluster of flowers

(d) Fruit—a pod

Fig. 10.8 Parts of the Flame of the Forest tree

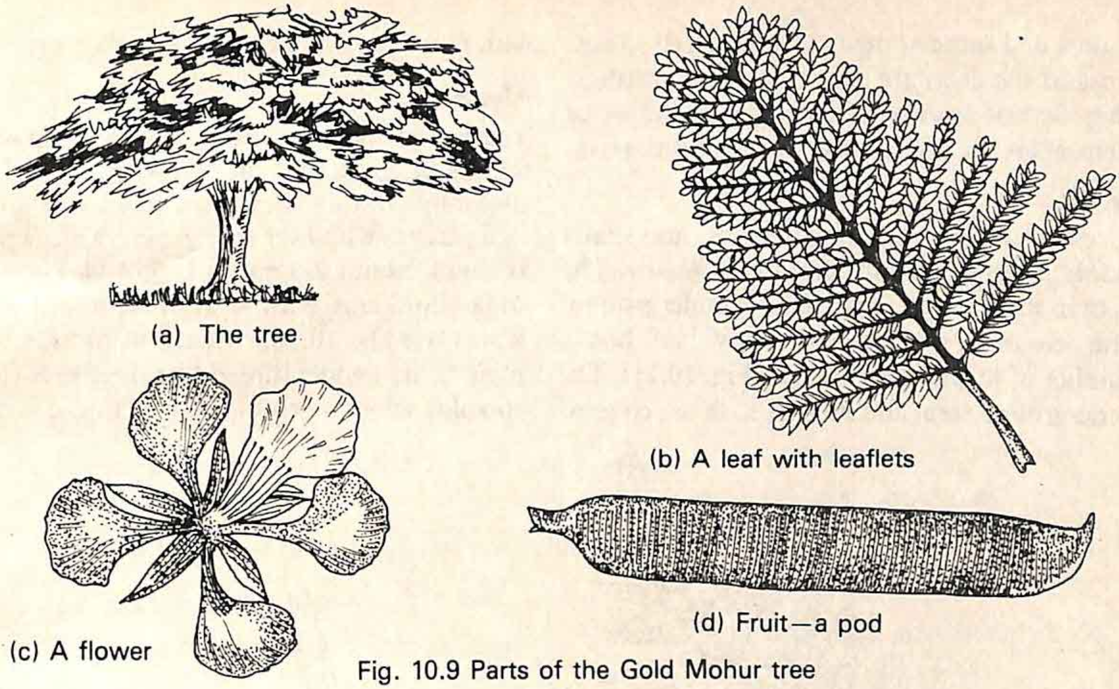
Gold Mohur (*Gul Mohur*)

It is a favourite ornamental tree in our gardens and along the road side (Fig. 10.9). It grows well in every part of the country and reaches a height of about 15-20 metres. Because of its heavy foliage, it is a nice shade tree.

It bears large leaves and each leaf has a large number of leaflets. The flowers are large and grow in bunches. They are of bright and scarlet yellow colour. Each flower bears a large, many-seeded pod which measures 30 to 40 cm in length and about 5 to 6 cm in width. The pod is initially green in colour but turns dark brown in colour when ripe.

Cactus

The growing and collecting of cactus (plural—cacti) plants has been a popular hobby for many. Cacti have varied shapes (Fig. 10.10) and


(a) The tree

(b) A leaf with leaflets

(c) A flower

(d) Fruit—a pod

Fig. 10.9 Parts of the Gold Mohur tree

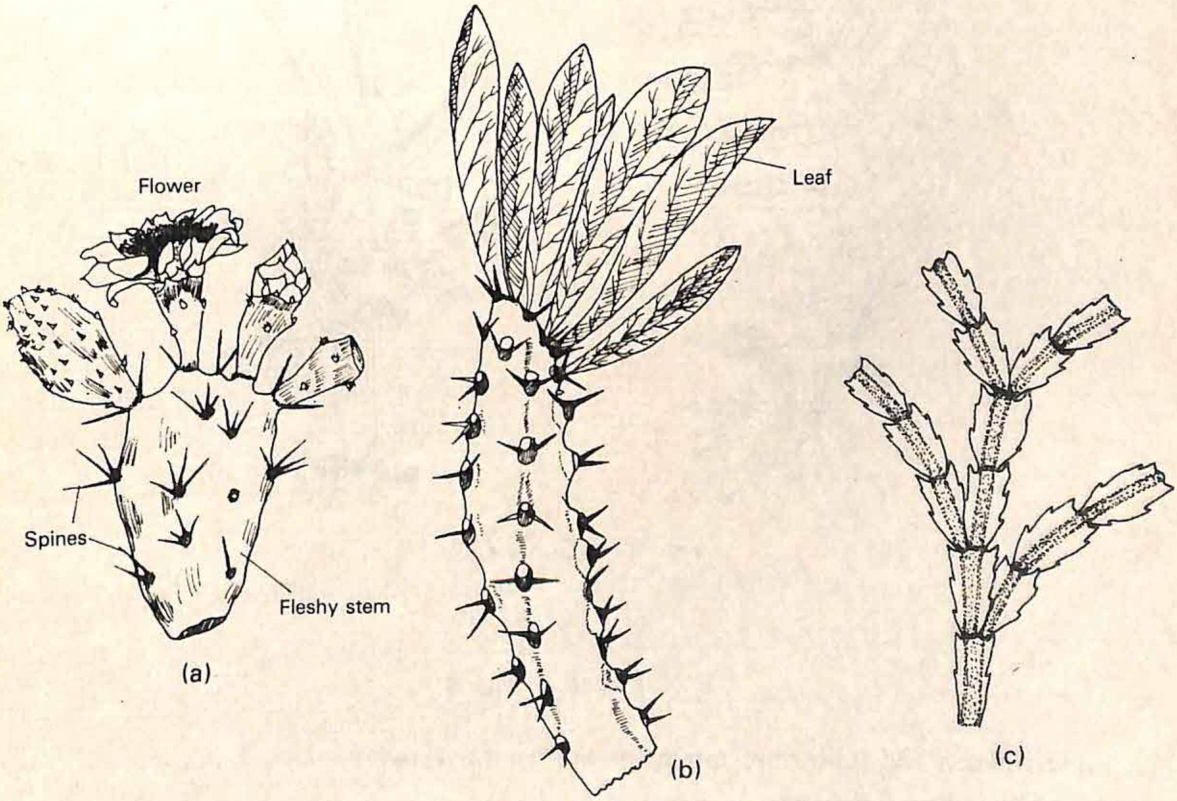


Fig. 10.10 Some Cacti

colours and some of them have coloured spines. Most of the cacti are grown by stem cuttings. They do not require much water and most of them grow well in sunny places and deserts.

Ferns

Ferns grow very well in cool, moist and shady places, both in the hills and in the plains. The stem in most of the fern plants is underground. The leaves are large and every leaf has a number of lobes called leaflets (Fig. 10.11). The underground stem and the leaf stalk are covered with numerous brownish scales called ramenta.

Mosses

These grow most commonly on old damp walls, trunks of trees, and on damp ground during the rainy season. They form green soft velvet-like patches wherever they grow. A moss plant is small, about 2-3 cm in height and consists of a short axis with spirally arranged small leaves (see Fig. 10.1b). Instead of roots, a moss plant bears slender thread-like structures called **rhizoids** which perfom the function of roots.

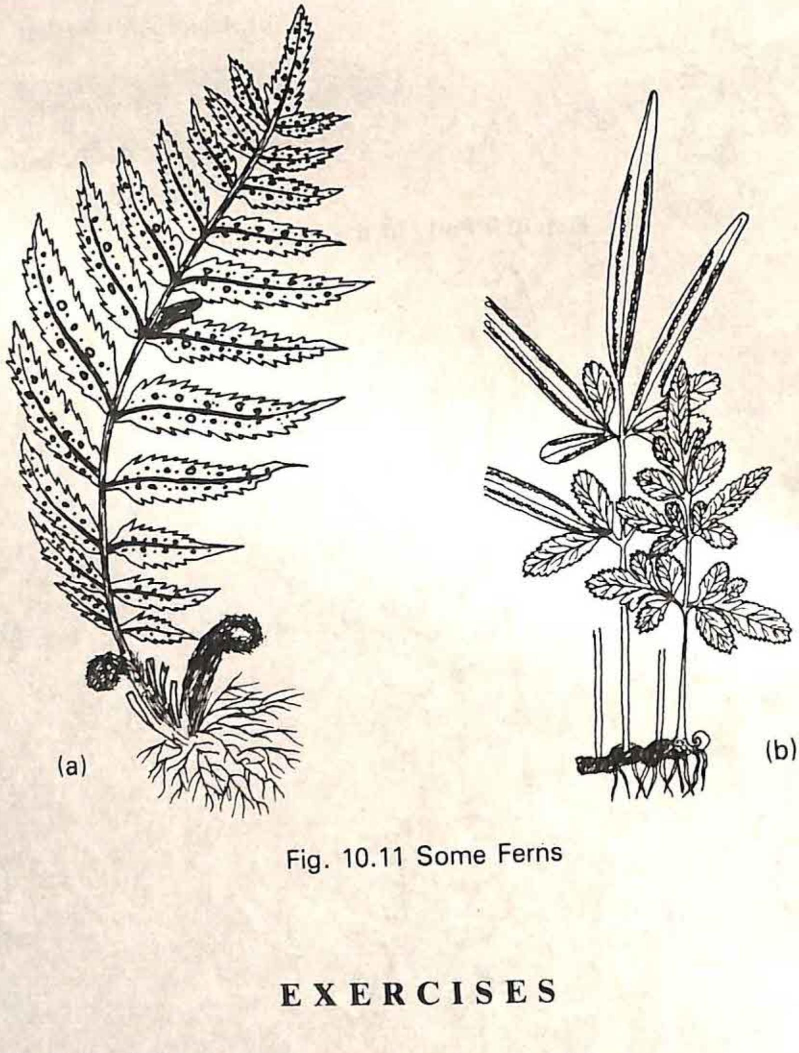


Fig. 10.11 Some Ferns

EXERCISES

1. State whether the following statements are true or false.
    - (i) Mosses bear flowers.
    - (ii) Mushrooms cannot make their own food.

(iii) Some bacteria can cause diseases.

(iv) Plants in which seeds are enclosed in fruits are known as gymnosperms.

(v) Gymnosperms have separate male and female flowers.

(vi) Wheat is a dicotyledonous plant.

(vii) Both creepers and climbers have soft stems and cannot stand erect.

(viii) Hibiscus is a biennial shrub.

(ix) Cactus cannot grow in dry regions.

2. Fill in the blanks.

(i) Mosses grow during the ______________________ season.

(ii) Algae ______________________ (can/cannot) make their own food.

(iii) The seed of a dicolyledonous plant has ____________ ____________.

(iv) Rice and wheat plants live for ______________________ year/years.

(v) Biennials ______________________ in the first year and produce ____________ and ______________________ in the second year.

(vi) ______________________, ______________________ and ____________ are soft-stemmed plants.

(vii) The slender thread-like structures which perform the function of roots in mosses are called ______________________.

3. Name three types of non-flowering plants, giving one example of each. ____________

____

____

4. What is the difference between

(i) A gymnosperm and an angiosperm? ______________________

____

____

(ii) A dicotyledonous and a monocotyledonous plant? ______________________

____

____

(iii) Annuals and perennials? ______________________

____

____

5. State one most important feature of each of the following and give one example of each.

(i) Herbs

(ii) Shrubs

(iii) Trees

(iv) Creepers

(v) Climbers

6. Draw diagrams of the leaves of (i) Margosa, (ii) Hibiscus (iii) Gold Mohur (iv) A fern

11

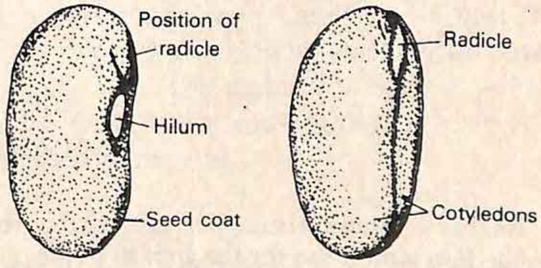
Flowering Plants

Most of the flowering plants which you come across in your daily life bear flowers, buds, leaves, branches, roots, etc. What functions are performed by each of these parts of a plant? How is a new plant formed? Before we learn all this, it is essential to know the structure of a seed.

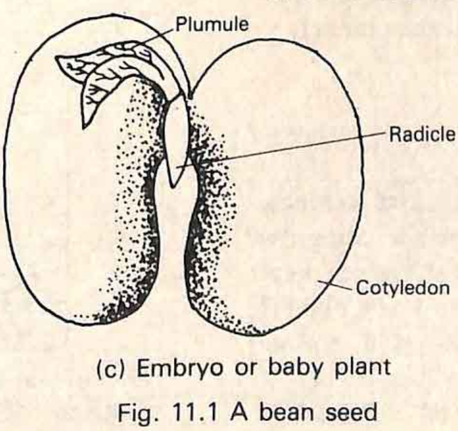
11.1 Structure of a Seed

Experiment 1. Select some bigger seeds such as those of bean or gram. Measure their length and width. Soak these seeds for about 12 hours in water. Drain off the water and measure the length and width of these seeds once again. Why is there an increase in the size of the seeds? This happens because the seed absorbs water and swells up.

The brown cover around the seed is called the **seed coat.** On one side of the seed you will see a scar called **hilum** (Fig. 11.1a). This is



(a) Outer appearance (b) Seed coat peeled off



(c) Embryo or baby plant

Fig. 11.1 A bean seed

where the seed was attached to the fruit with the help of the stalk. The function of the seed coat is to protect the seed. Peel off the seed coat gently. You will notice two large whitish and thick seed leaves or **cotyledons** (Fig. 11.1b). Carefully pull the two cotyledons apart. You will find a delicate part called **embryo** or the baby plant enclosed and protected between the two cotyledons (Fig. 11.1c).

Look at the embryo carefully. You will notice a small baby root or **radicle** and a baby shoot or **plumule** (Fig. 11.1c).

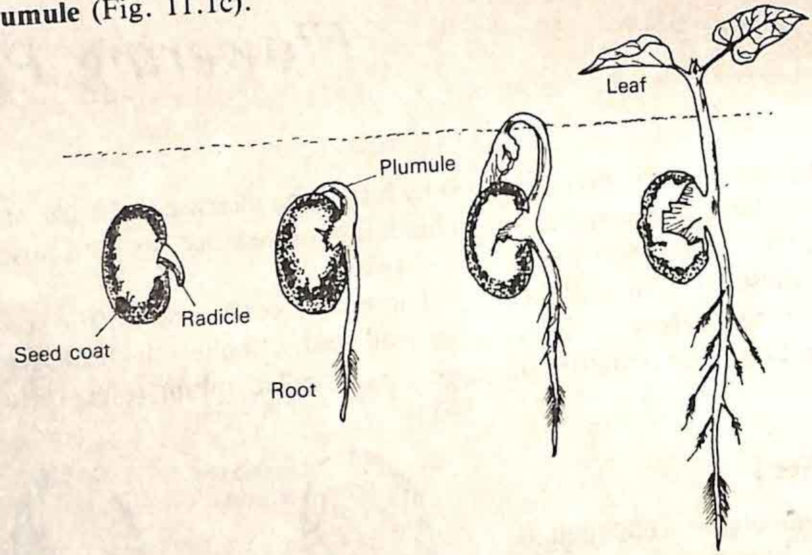


Fig. 11.2 Germination of bean seed

Besides protecting the embryo, the cotyledons store food for the growth of the seed into a plant. The radicle gives rise to the root and the plumule to the shoot of the plant (Fig. 11.2).

11.2 Germination of Seeds

The function of a seed is to give rise to a new plant. Under what conditions will a seed grow into a new plant? Why don't dry seeds kept stored for a long time give rise to new plants? For their growth, the seeds need special conditions. The process by which the seeds grow into new plants when they get these special conditions is called **germination.** What are these special conditions?

Experiment 2. Take three dry bean seeds and tie them to a 15 cm long plastic strip or foot ruler with the help of a thread, as shown in Fig. 11.3. Take a beaker. Put the foot ruler with the three seeds into the beaker. Pour water into the beaker so that the lowest seed is completely under water, the middle one is partly in water and partly in the air while the uppermost seed is completely in the air.

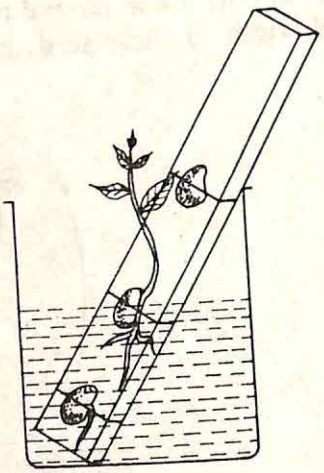


Fig. 11.3 Experiment to demonstrate conditions necessary for germination

Leave the beaker in a warm place for a few days and observe the changes that occur. Keep on adding water into the beaker to ensure that the middle seed is always partly in water and partly in air.

You will observe that the lowermost seed does not germinate properly, the middle one germinates to form a small root and a small shoot, while the uppermost seed does not germinate at all. What do you conclude about the conditions necessary for germination, from this experiment?

Three things which the seeds require for their germination are water, air and a suitable temperature. Which seed in the above experiment got water, air and a suitable temperature?

11.3 Parts of a Flowering Plant and Their Functions

A flowering plant has two main parts: the root, which is below the ground and the shoot, which is above the ground.

Experiment 3. Pull out a mustard plant (Fig. 11.4) taking care not to injure any part of the plant. You will have to use a little force to pull it out. Why is this force necessary? Gently wash the part of the plant which was under the ground. How does the root differ from the shoot? Make a list of all the differences you can observe.

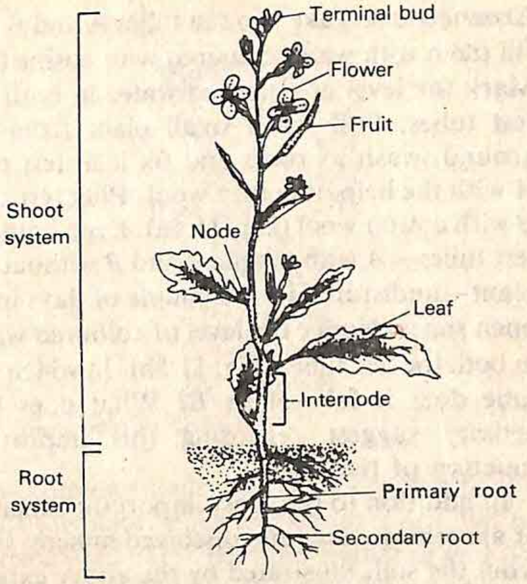


Fig. 11.4 A mustard plant

The Root

The root grows from the radicle of the seed. It consists of a main root and its branches. The main root is thicker and larger and grows deep into the soil. The main root bears branches which in turn bear more branches to form a network in the soil.

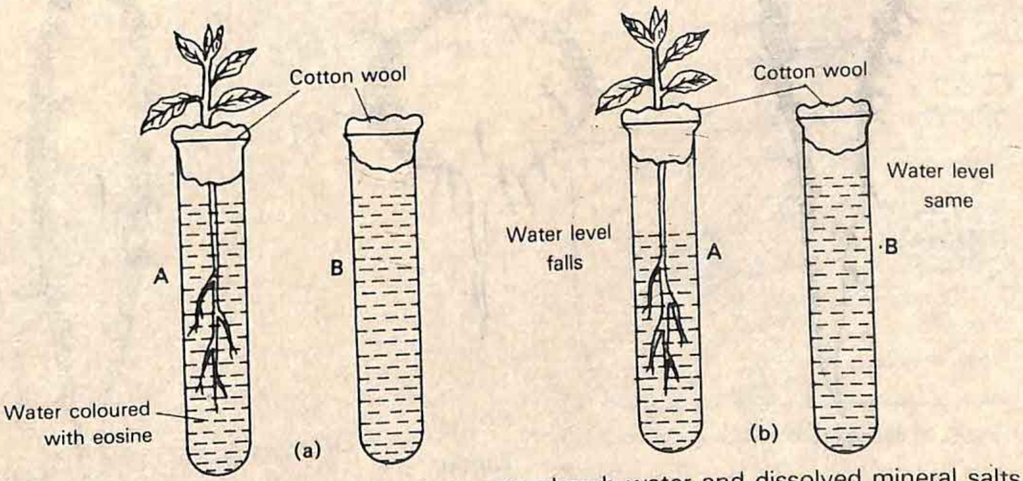


Fig. 11.5 Experiment to show that roots absorb water and dissolved mineral salts

Experiment 4. Take two test tubes A and B and **fill** them with water coloured with eosine dye. **Mark** the level of coloured water in both the test tubes. Pull out a small plant from the ground, wash its roots and fix it in test tube *A* with the help of cotton wool. Plug test tube *B* with cotton wool (Fig. 11.5a). Keep both the test tubes—*A* with the plant and *B* without the plant—undisturbed for a couple of days in an open space. Notice the level of coloured water in both the test tubes (Fig. 11.5b). In which test tube does it fall—*A* or *B*? What does this activity suggest regarding this important function of the root?

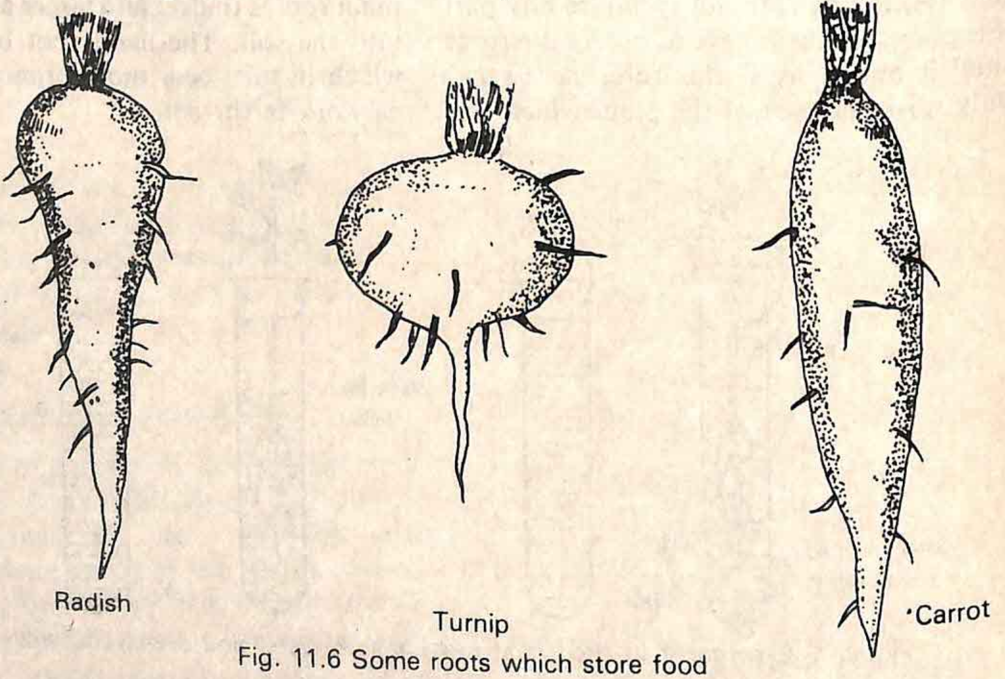
In addition to the most important function of absorbing water and dissolved mineral salts from the soil, illustrated by the above experiment, the roots perform other functions also. They fix the plant firmly in the soil, carry the water and soluble mineral salts which they absorb from the soil to the stem, and also store some of the surplus food as in carrot, radish, beet, turnip, etc (Fig. 11.6).

The Stem

The shoot grows from the plumule of the seed. It consists of the main stem, its branches, leaves, buds, flowers and fruits with seeds (Fig. 11.4). The place where a leaf is attached to the stem is called the **node.** The part of the stem between two successive nodes is called the **internode.** At the tip of the stem or of a branch, there is a **terminal bud** which helps in the upward growth of the plant. A terminal bud may give rise to a bunch of flowers also. The angle between a leaf and the stem or its branch is called an **axil.** There is always an **axillary bud** present in an axil, which gives rise to a new branch and helps in the sideways growth of the plant. Like a terminal bud, an axillary bud may also give rise to a bunch of flowers.

Some of the functions of the stem are as follows.

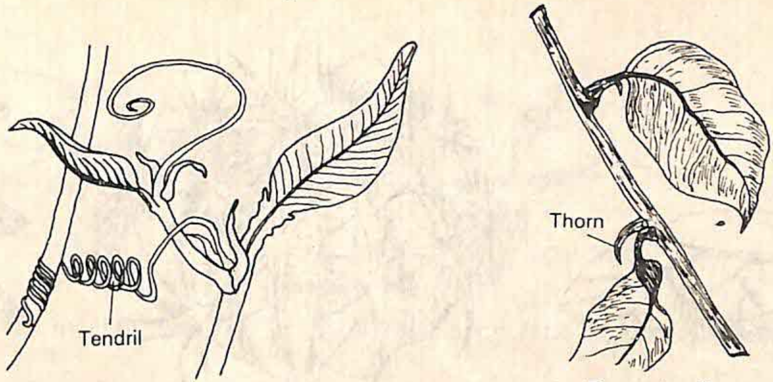
(i) It carries water and soluble mineral salts from the roots to the leaves and other parts of the plant.
(ii) It carries the food prepared in the leaves to all the parts of the plant.
(iii) It bears the weight of the fruits, flowers, branches and leaves, and thus supports the plant.


Radish

Turnip

Carrot

Fig. 11.6 Some roots which store food



Passion flower

Bougainvillea

Fig. 11.7 Some stems which help in climbing

(iv) In some plants, such as ginger and potato, the stem is specialized to store food.

(v) In some plants growing in dry regions, such as cacti and spurges, the stem stores large quantities of water.

(vi) In young plants, it helps in making food.

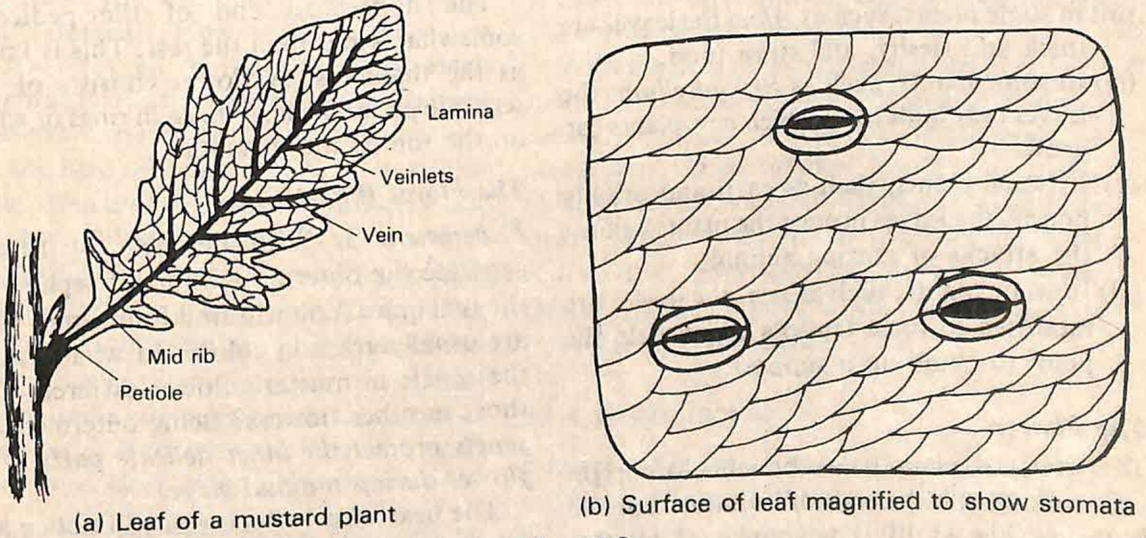
(vii) In some plants, the stem helps the plant to climb up and also protects it from the attacks of grazing animals, e.g. passion flowers and bougainvillea (Fig. 11.7).

The Leaf

The mustard plant bears a number of leaves (Fig. 11.8a). The size of the leaves keep on becoming smaller and smaller towards the tip of the plant. Each leaf consists of a flat green expanded part called the **lamina** or **leaf blade,** and is attached to the stem by a narrow and short stalk called the **petiole.** The leaf blade has a main vein called **mid rib** and many small veins forming a network. The mid rib and the veins support the leaf blade and keep it flat and exposed to sunlight for making food.

The most important functions of leaves are as follows.

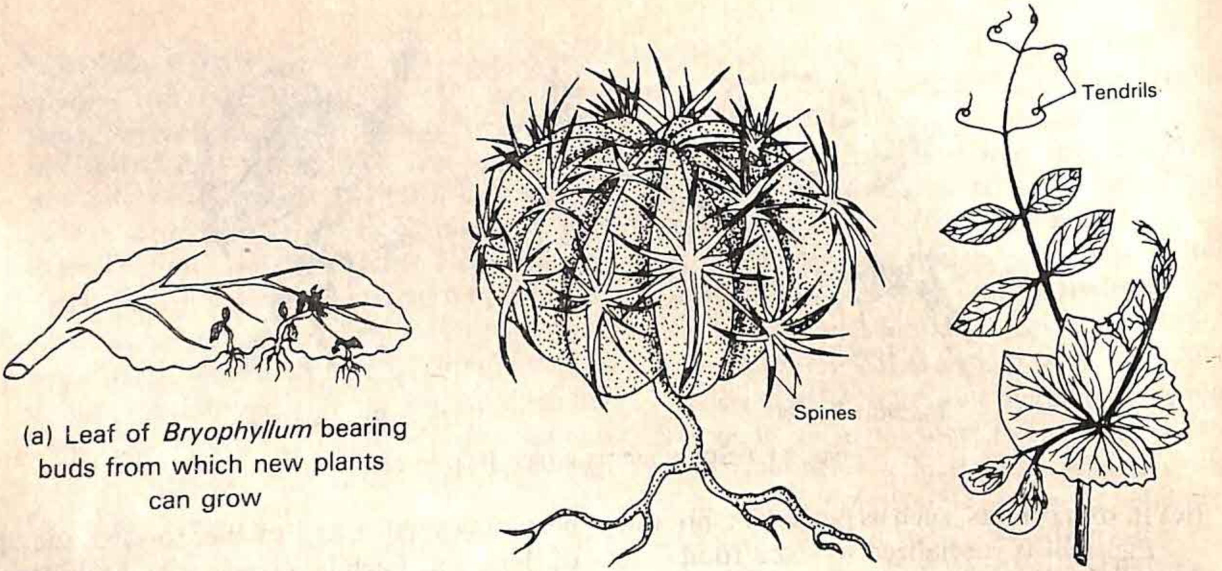
(i) Leaves contain a green pigment called **chlorophyll** which helps the leaves to make food for the plant in the presence of sun-



(a) Leaf of a mustard plant

(b) Surface of leaf magnified to show stomata

Fig. 11.8



(a) Leaf of *Bryophyllum* bearing buds from which new plants can grow

(b) Leaves of cactus modified to form spines for protection

(c) Leaves of pea modified into tendrils for climbing

Fig. 11.9 Some functions of leaves

light. This process of making food is known as **photosynthesis.**

(ii) Leaves have very small holes called **stomata** on their surface (Fig. 11.8b). The plants absorb carbon dioxide from the air through these holes for photosynthesis. They also absorb oxygen from the air through these holes for respiration.

(iii) In some plants, such as *Aloe,* the leaves are thick and fleshy, and store food.

(iv) In some plants, such as *Bryophyllum,* the leaves bear buds from which new plants can grow.

(v) In some plants, such as cacti and prickly poppy, the leaves protect the plants against the attacks of grazing animals.

(vi) In some plants, such as pea, the leaves are modified to form **tendrils** which help the plant to climb up a support.

The Flower

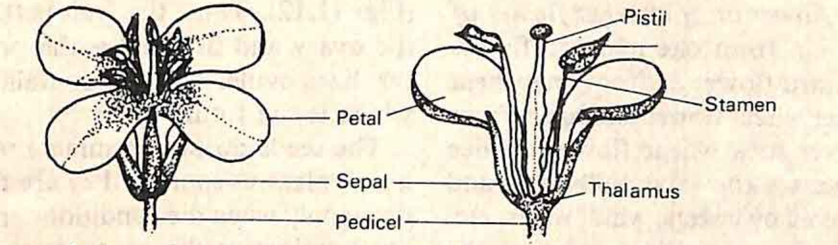
The mustard plant bears bunches of bright yellow flowers at the ends of its main stem and branches (Fig. 11.10). Each bunch is known as an **inflorescence.** It consists of a main axis on which the flowers are borne. Each flower has a stalk called **pedicel** with which it is joined to the main axis. The younger flowers, which have short stalks, are found higher up on the main axis, and the older flowers with longer stalks are found lower down on the main axis.

The uppermost end of the pedicel is somewhat wider than the rest. This is known as the **thalamus**. A flower consists of four separate parts which are fixed in rings or whorls on the top of the thalamus.

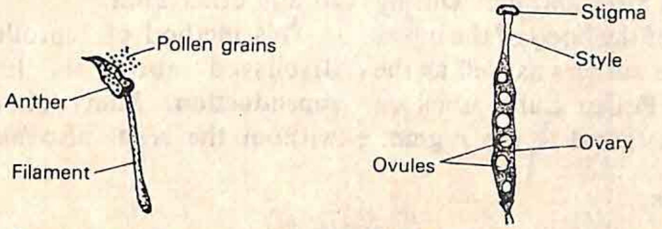
The Floral Whorls

Experiment 5. With the help of forceps, separate the outermost whorl of **sepals** from the thalamus. You will find four sepals which are usually green in colour. In what way are the sepals in mustard flower different from those in other flowers? Being outermost, *the sepals protect the inner delicate parts of the flower during the bud stage.*

The next whorl which you will notice after separating the sepals is that of **petals.** Notice



(a) The mustard flower (b) Vertical section of a mustard flower



(c) Stamen and pollen grains (d) Pistil and ovules

Fig. 11.10

the colour and number of petals. You will find that they are four lemon yellow petals. Are the petals scented? *The bright colour and strong scent of the petals helps to attract insects that help in reproduction.*

Gently remove all the petals from the thalamus and you will notice the third inner whorl of **stamens.** How many stamens are there? Are they all of the same size? Each stamen consists of a thin green stalk or **filament** and a yellow cap-like head called the **anther.**

With the help of a pair of fine scissors, cut an anther from an older mustard flower. Place it on a sheet of black paper and crush it gently. You will notice fine dust-like particles coming out of the anthers. These are called **pollen grains** (Fig. 11.10c) and are produced within an anther. Each pollen grain has two special cells called male sex cells which take part in reproduction. Thus *stamens are the male organs of reproduction of a flower.*

Carefully examine the thalamus near the base of each stamen. You will notice small light green swellings. How many are these? These are called **nectaries** which produce a sugary liquid called **nectar** on which the insects feed.

After removing all the stamens, you will notice innermost whorl called **pistil.** It consists of three parts. The longer and wider lowermost part is called the **ovary**, the short upper part is called the **style** and the cap-like portion on the top is called the **stigma.**

With the help of a sharp razor blade, cut the ovary into two halves along its length. You will notice a large number of small ball-like structures called **ovules** inside the ovary (Fig. 11.10d). Ovules are produced within the ovary. Each ovule has a special cell called female sex cell which takes part in reproduction. Thus the *pistil is the female organ of reproduction of a flower.*

11.4 Reproduction

For reproduction, it is very essential for the male sex cell borne within the pollen grain to unite with the female sex cell borne within the ovule. First of all, the pollen grains are transferred from the anther to the stigma of either the *same flower* or *of another flower of the same type,* i.e. from one mustard flower to another mustard flower or from one wheat flower to another wheat flower and *never* from a mustard flower to a wheat flower or vice versa. This process is known as **pollination** and is generally effected by insects, wind, water, etc.

Attracted by the colour and scent of the flowers, and in order to feed on the nectar, the insects visit one flower after another. During these visits, some part of the body of the insect gets rubbed against the anthers as well as the stigma of the flowers. Pollen grains stuck on the body are thus transferred to the stigma.

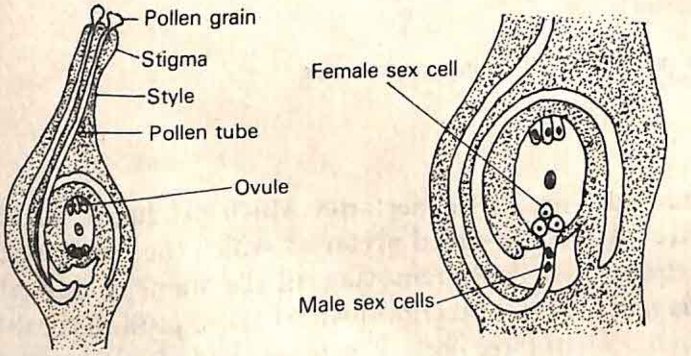


Fig. 11.11 The process of fertilisation in a flowering plant

Pollen grains start germinating on the stigma and each pollen grain forms a tube called a **pollen tube.** The pollen tube bores its way through the stigma and style to reach the ovary and enters an ovule (Fig. 11.11). Each pollen tube contains two male sex cells at its tip and carries them into the ovule. Within the ovule, the tip of the pollen tube breaks and one of the male sex cells joins with the female sex cell present in the ovule. The process of fusion of the male sex cell with the female sex cell is known as **fertilization**.

After fertilization, sepals, petals, stamens, stigma and style of the flower start drying up and gradually they fall off. At the same time, each fertilized ovule starts growing into a seed and the ovary as a whole grows into the fruit (Fig. 11.12). Thus, the fruit is the product of the ovary and the seed is the product of the fertilized ovule. The seed contains an embryo, which is the future plant.

The seeds do not germinate to give rise to a new plant as soon as they are formed. They do so only when the conditions are favourable. On germination the mustard seeds will always give rise to new mustard plants only and not to any other kind.

This method of reproduction by seeds as discussed above is known as **sexual reproduction.** Many plants can reproduce without the seeds also and this method of reproduction is known as **vegetative reproduction.** This takes place when a portion of a plant gets separated from the parent plant and starts growing into an independent plant. Man makes use of this method of reproduction for his own benefit, and grows many plants by this method. For example, during favourable conditions, if you cut a 25 cm long piece of stem from a rose or night jasmine plant and fix it in moist soil in such a way that about 10 cm of this stem cutting remains within the soil and the rest in the air, it will grow into a new rose or night jasmine plant after about 2 to 3 weeks. The buds in the part of the stem which was in the air grow into young shoots. At the same time, roots will develop on the part of the stem which was under the soil.

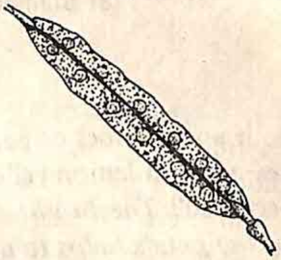


Fig. 11.12 The mustard fruit

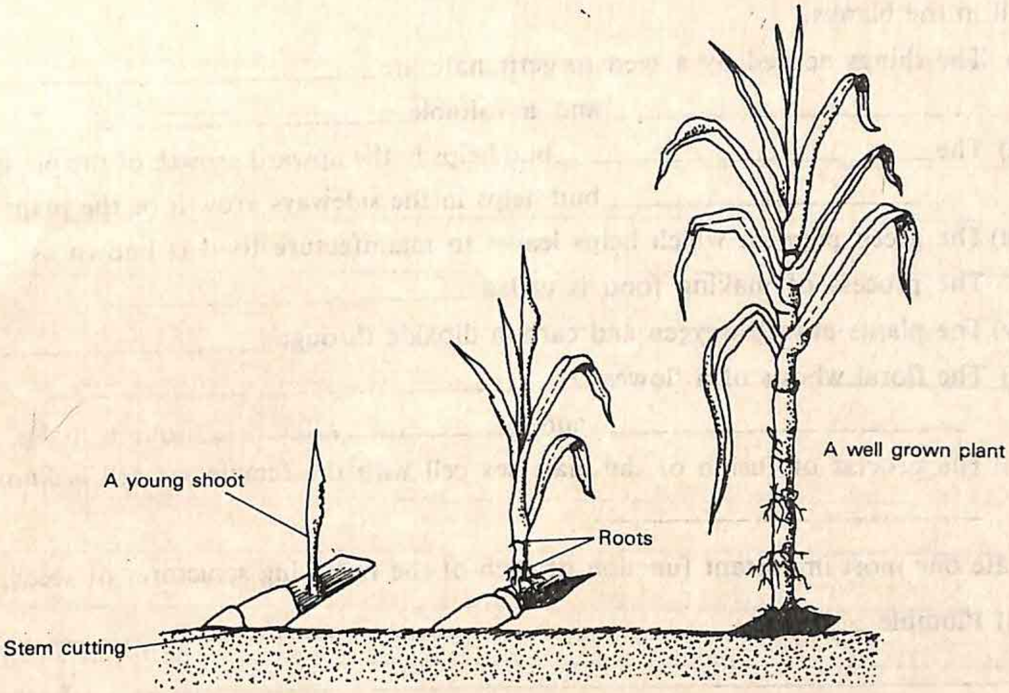


Fig. 11.13 A sugarcane plant grown from a stem cutting

If this young plant developed from a stem cutting continues to receive sufficient water and mineral salts from the soil, it will grow into an independent plant in due course. Some other plants which are grown by vegetative reproduction are potato, ginger, mint, sugarcane, dahlia, lilies, begorua, sweet potato, tulip, tuberose, etc.

EXERCISES

1. State whether the following statements are true or false.
   (i) The radicle of a seed grows into the root, and the plumule into the stem.
   (ii) The only function of the cotyledons is to protect the embryo.
   (iii) The root sometimes stores surplus food.
   (iv) The main function of the root is to fix the plant to the soil.
   (v) Leaves use oxygen and sunlight to manufacture food.
   (vi) A bunch of flowers is known as an inflorescence.
   (vii) The male sex cells are present in pollen grains.
   (viii) Reproduction by the fusion of male and female sex cells is known as vegetative reproduction.

2. Fill in the blanks.

(i) The things needed by a seed to germinate are______________________,
______________ and a suitable______________.

(ii) The______________bud helps in the upward growth of the plant. The
______________ bud helps in the sideways growth of the plant.

(iii) The green pigment which helps leaves to manufacture food is known as ______
The process of making food is called ______________.

(iv) The plants absorb oxygen and carbon dioxide through ______________.

(v) The floral whorls of a flower are______________, ______________,
______________ and ______________.

(vi) The process of fusion of the male sex cell with the female sex cell is known as
______________.

3. State one most important function of each of the following structures of seeds.

(i) Plumule______________________________

____

(ii) Radicle______________________________

____

(iii) Seed coat______________________________

____

(iv) Cotyledons______________________________

____

4. State the important functions of the following. Do not mention specialized functions but only those which are common to all flowering plants.

(i) Root______________________________

____

____

____

____

(ii) Shoot______________________________

____

____

(iii) Leaf

5. Explain the following terms.

(i) Pollination

(ii) Fertilisation

(iii) Vegetative reproduction

6. State one important function of the following parts of a flower.

(i) Sepals

(ii) Petals

(iii) Stamens

(iv) Nectaries

(v) Ovary

. Draw labelled diagrams of the following.

(i) A mustard plant showing the main parts.
(ii) A germinating seed.
(iii) A mustard flower showing the four whorls.

12

Animal Life—Insects

There is a vast variety of animals around us. They live on land, in the waters of rivers, ponds, lakes and seas and can also be seen flying about in the air. Some of them live on trees, in dense forests, on mountains, in deserts, marshes, swamps and even on the frozen ice caps near the North and South Poles. Animals and plants live together in all types of environments to which they are well adapted. For their survival, the animals and plants are dependent not only on their environment but also on each other in many ways. Can you list some of the ways in which animals and plants help each other? How do the fishes living in a pond help the algae and other plants growing in that pond? How do these plants help the fishes in that pond?

If you are asked to name a few animals, many of you may perhaps just name animals such as lion, tiger, cow, dog, cat, frog, fly, etc. However there are millions of animals which vary in size from an *Amoeba* which can only be seen under a microscope, to the blue whale—the largest of all animals measuring between 24 and 30 metres in length. The entire animal kingdom consists of two types of animals.

(i) **Invertebrates** such as *Amoeba,* sea-anemone, tapeworm, earthworm, insects, snail, star-fish, etc., *which do not have a backbone.*

(ii) **Vertebrates** such as fishes, frog, toad, lizard, snakes, birds, leopard, rabbit, whale, etc., *which have a backbone.*

To know more about animals and the way they live let us study about some insects first.

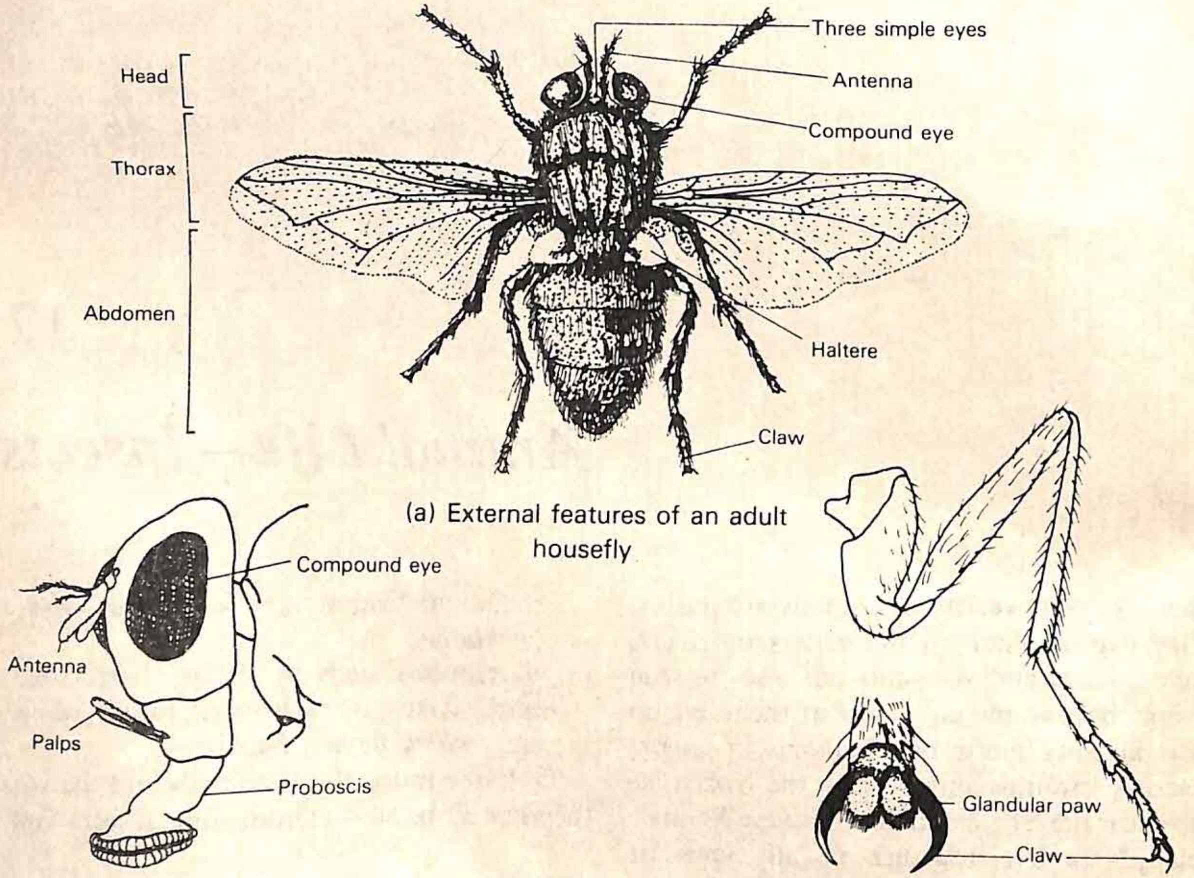
12.1 Housefly

Structure

Housefly is a household **pest.** Do you know what pests are? How do the pests affect our lives?

The body of a housefly is divided into three parts: head, thorax and abdomen (Fig. 12.1a). The head bears two compound eyes, three simple eyes, two antennae or feelers, and a tube-like proboscis with two palps. The mouth is at the end of the proboscis (Fig. 12.1b). The antennae and the palps are sense organs of touch, taste and smell. The proboscis helps in feeding. The compound eyes help the animal to see in all directions.

The thorax bears a pair of wings which help in flying. Halteres or balancers are two small projections on the thorax, just behind the wings. They help to balance the fly during flight



(a) External features of an adult housefly

(b) Head of housefly showing proboscis

Fig. 12.1

(c) Detailed structure of leg of housefly

and are also believed to be sensory organs. The thorax also bears three pairs of jointed hairy legs, each with two curved claws and glandular pads at its end (Fig. 12.1c). A sticky fluid produced by the pads helps the fly to cling and walk even on smooth surfaces like glass. The curved claws help the fly to walk on rough surfaces. The abdomen consists of eight segments but only four are visible.

Life History

There are separate male and female houseflies. The female is slightly bigger than the male. Mating takes place during the breeding season, which in India is from March to September.

About four days after mating, the female begins to lay eggs in dung, human wastes, and decaying organic matter such as fruits, vegetation or flesh. It lays about five to six batches of 100 to 125 eggs in its lifetime of about two and a half months. Each egg is cylindrical, white and shiny. It is about 1 mm long. If there is enough warmth, moisture and darkness, each egg hatches into a tiny larva within a day (Fig. 12.2).

Each larva is soft, segmented and creamy white. It measures about 2 mm in length. It does not have any head or legs and is known as **maggot.** It has a mouth at the pointed front end. It breathes with the help of two pairs of holes called **spiracles** and moves with the help of pads. It feeds on fluids and grows rapidly to about 12 mm in length in about six to eight days. During this period, it **moults** or sheds its old skin twice. At the end of the larval period,

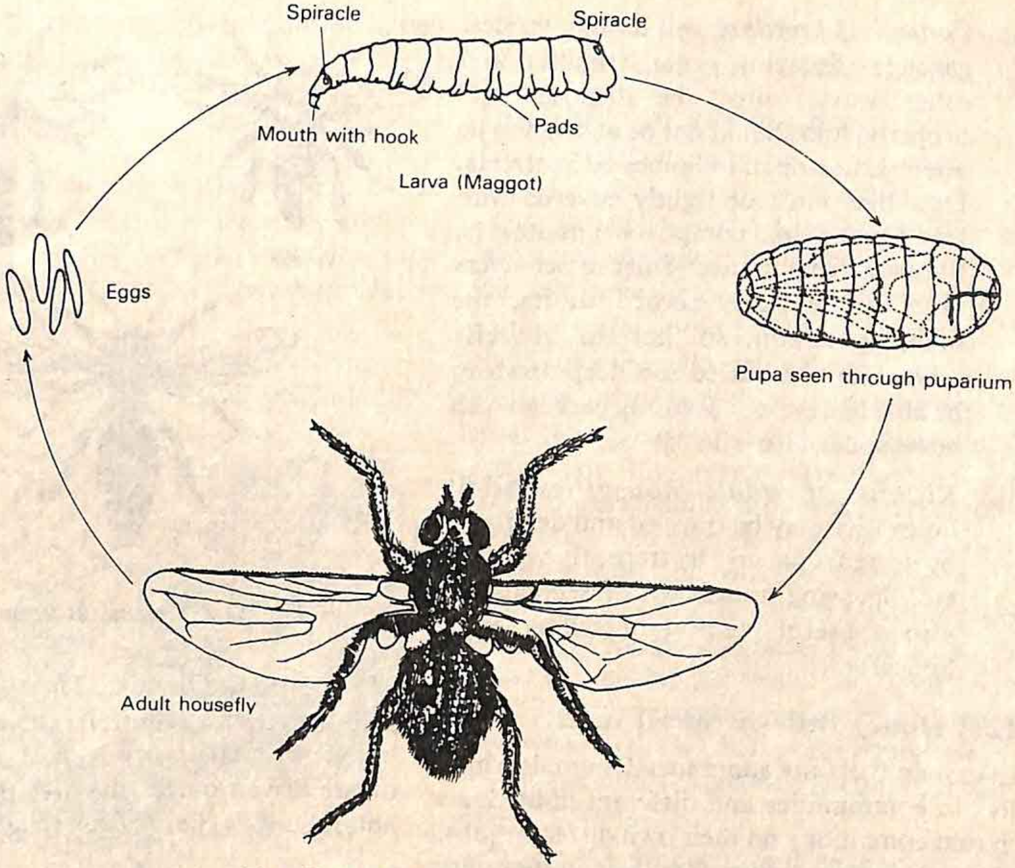


Fig. 12.2 Life history of a housefly

it moves to a drier place and shrinks to form a **pupa.**

The pupa lives within a stiff and protective case called **puparium,** which is formed out of the last larval skin. The dark brown coloured puparium is barrel shaped with rounded ends and is about 6 mm in length. It is inactive throughout the pupal stage which lasts only for about four to five days. At the end of this period a fully formed housefly crawls out of it and flies off. In about ten days time, it becomes capable of reproduction.

Control of Houseflies

Houseflies carry millions of microbes which cause diseases such as cholera, typhoid, diarrhoea, dysentry, tuberculosis, leprosy, etc. These microbes stick to the body parts of the houseflies when they feed on the wastes and are transferred to the human food when they feed on it later on. Houseflies also carry microbes in their bodies and transfer them to the human food through their saliva and faeces.

Because of the great danger of disease from the activities of houseflies, it is very necessary to control them. Some of the measures which may be adopted against houseflies are:

(i) *Protection of food:* All food must be kept properly covered. Food which houseflies have visited and contaminated must not be eaten. Doors and windows in kitchens and eating places must be screened.

(ii) *Control of breeding:* All human wastes, garbage, decaying organic matter and other wastes must be disposed off properly, and should not be allowed to lie about in the open in homes or in streets. Dust bins must be tightly covered with lids. Manure and compost heaps must be far away from houses. Their upper layers must be regularly turned during the breeding season, so that the housefly larvae may be buried too deep down to be able to develop. Treating garbage with insecticides also kills larvae.

(iii) *Killing of adult houseflies:* Adult houseflies may be trapped and destroyed by using fly papers, fly traps, fly swatters, etc. Spraying houses with insecticides is also a useful method of killing adult houseflies.

12.2 Honey Bee—A Social Insect

Like man there are some social animals which live in communities and different individuals in that community do their own different jobs. However, all members of their community work as a team for the common welfare of one and all.

Honey bee is an example of a social animal. Honey bees live in a colony or swarm called **beehive** which may contain about 80,000 individuals. There are three types or 'castes' of individuals in a colony (Fig. 12.3).

(i) Queen
(ii) Drones, and
(iii) Workers

Queen

There is only one queen in a beehive. It is the female bee and its work is to lay fertilized eggs throughout its life of about five years. It has a very long and narrow abdomen which extends beyond the wings.

Drone

Drones are the male bees and there are about 200 of them in a beehive. Their work is to mate with the queen and fertilize the eggs within her body. After this work is over, the drones die or are driven out of the hive by the workers and then they die. A drone has a shorter and

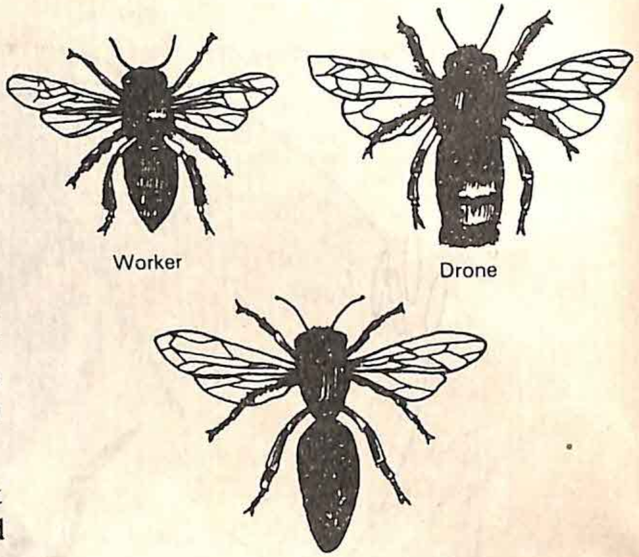


Fig. 12.3 'Castes' of honey bee

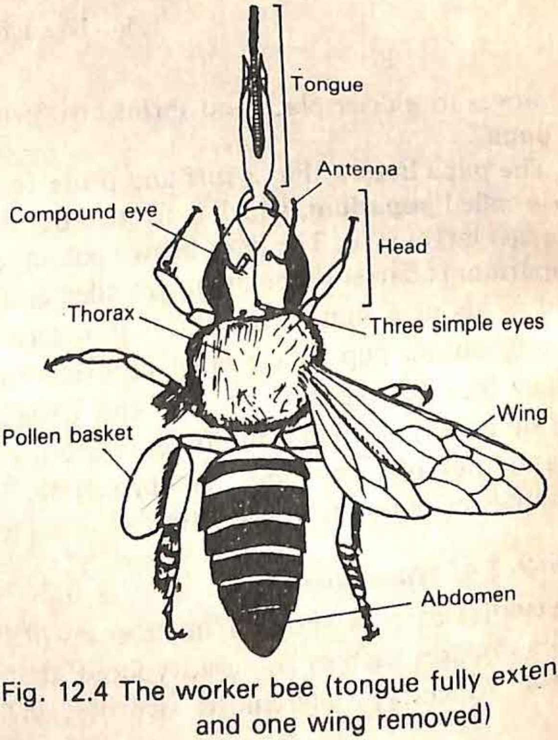


Fig. 12.4 The worker bee (tongue fully extended and one wing removed)

broader abdomen as compared to the abdomen of the queen. Its wings do not cover the abdomen fully.

Worker

There are thousands of workers (Fig. 12.4) in a hive. A worker is smaller in size as compared to the queen or a drone and its wings cover the abdomen fully. The workers have many duties to perform. They

(i) build more cells in the beehive.
(ii) collect both nectar and pollen grains.

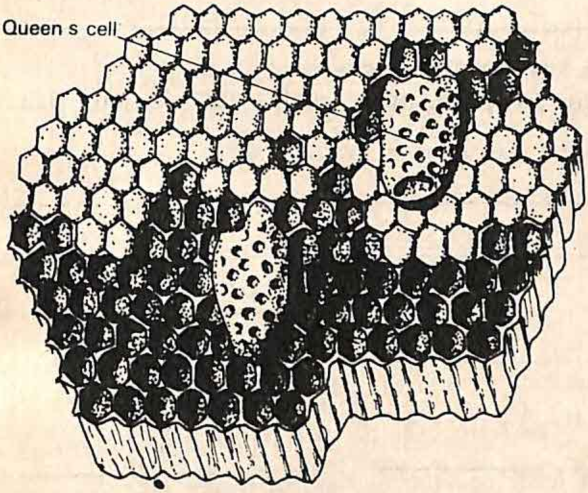


Fig. 12.5 A beehive

(iii) keep a constant watch on the hive and do not allow the enemy to enter the hive and take away honey.
(iv) keep on fanning the hive with their wings to let fresh air move through the hive.
(v) remove dead bees and wastes from the cells and keep the hive clean, etc.

Life History of a Honey Bee

The queen lays fertilized eggs either in the workers' cells or in a queen's cell, and unfertilized eggs in the drones' cells. The eggs take about three days to hatch into a larva. For the first three days all the larvae are fed with a milky white liquid produced by the salivary glands of workers. During the rest of the larval life, they are fed with different diets: the worker larvae receive honey, drone larvae receive pollen grains and the queen larvae receive royal jelly—a special liquid produced by some glands of workers. The cells are stored with honey and pollen grains and on the ninth day after hatching, they are then sealed with a porous cap of wax and pollen grains. In the mean time, larvae change into pupae and finally into young bees. The queen pupae emerge on the sixteenth day, whereas the workers take twenty-one days to emerge and the drones twenty-four days, after hatching.

When the young queen emerges, the old queen leaves the hive along with a number of workers and settles on a safe place. The young queen which emerges first of all kills other young queens with her sting. A week after emergence, the young queen goes on a mating flight during which it is fertilized by a drone. After this, the drone dies and the queen returns to the hive and starts laying eggs. Thus the life cycle continues.

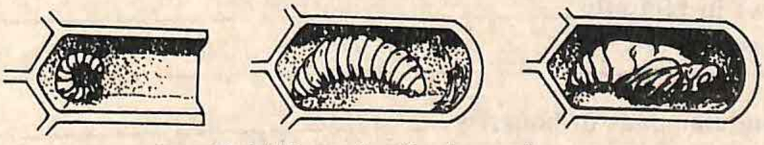


Fig. 12.6 Life cycle of a honey bee

EXERCISES

1. Name three animals and three plants living in each of the following places.

(i) Deserts____

(ii) Frozen ice caps at the poles

(iii) Ocean depths

2. (i) What is the main difference between vertebrate and invertebrate animals?

(ii) Classify the following as vertebrates and invertebrates.
Donkey, bat, seahorse, lobster, leech, scorpion, man, turtle, starfish, jelly fish, penguin.

Vertebrates

Invertebrates

3. State the functions of the following.

(i) Drone

(ii) Proboscis in housefly

(iii) Palps in housefly

(iv) Claws in housefly

(v) Glandular pads in housefly

(vi) Puparium

(vii) Spiracles in insects

(viii) Queen honey bee

4. (i) Name three diseases with houseflies spread.

(ii) State three ways of protection against houseflies.

5. State whether the following statements are true or false.
(i) No animals live on the frozen ice caps at the North and South Poles.
(ii) A housefly lives for two to two and a half years.
(iii) Moulting is the shedding of old skin.
(iv) A housefly becomes capable of reproduction in about ten days from the time it is formed from the pupa.
(v) Houseflies spread several diseases.
(vi) There are several queens in a beehive.
(vii) A queen bee lives for 4-5 months.
(viii) The queen bee which emerges first kills all other young queens.
(ix) Antennae in insects are sense organs.

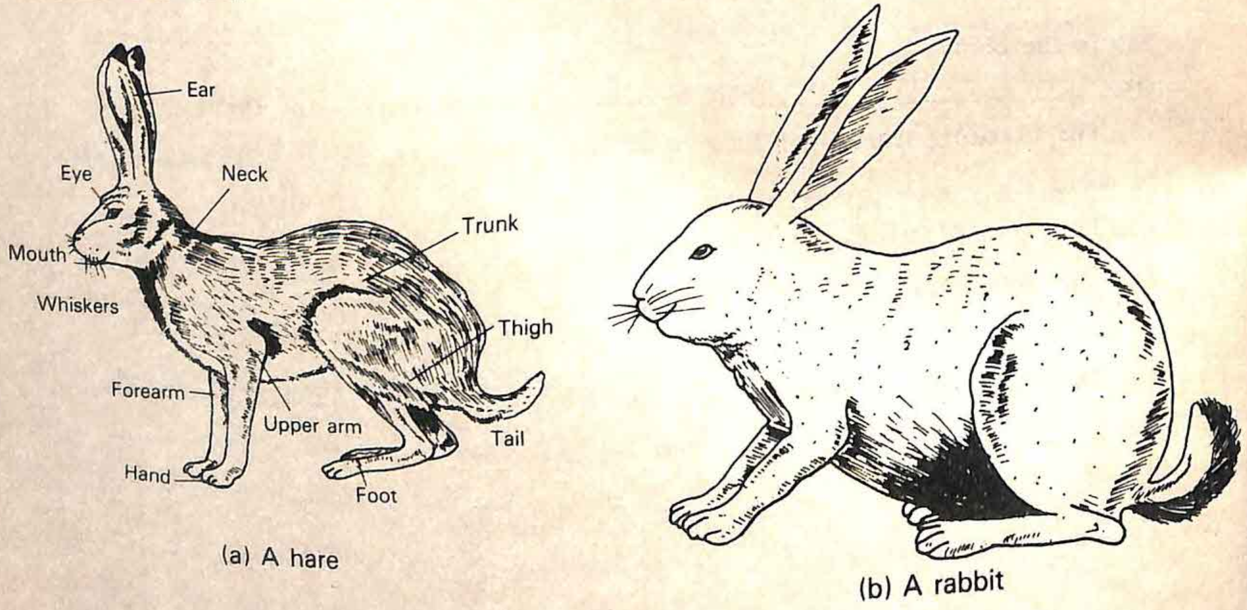
6. Fill in the blanks.
(i) ______ help to balance the housefly during flight.
(ii) The breeding season for flies in India is from ______ to ______ .
(iii) The larva of a housefly is known as ______
(iv) The pupal stage in a housefly lasts from ______ to ______ days.
(v) The three 'castes' in honey bees are ______ ______ and ______

13

Animal Life—Mammals and Birds

Animals and plants living a natural life in their natural surroundings or habitat are known as wild animals and plants.

Mammals are animals which feed their young with milk produced by **mammary glands** of the female, i.e. they suckle their young. Man, dog, cat, lion, wolf, etc. belong to this class of animals. The body of a mammal is covered with a fur of hair and that of a bird with feathers. Hair and feathers help the animals to maintain a constant body temperature. Of what use is a constant body temperature to an animal? Besides this, the colour of the hair and the feathers help the animals to disguise themselves by blending with the colour of their surroundings, to escape the watchful eyes of



(a) A hare

(b) A rabbit

Fig. 13.1

their natural enemies. Let us now study about the habits of mammals and birds.

13.1 Mammals

Hare

Hares (Fig. 13.1a) are found in grasslands and forests in Europe and Asia. They are gentle and harmless mammals. They live in hollows in the ground. They protect themselves by hiding in these hollows. While in danger, they give danger signals to other hares by grinding their upper front teeth (incisors) against the lower ones. They can run fast with a speed of about 60-70 km p.h.

The colour of a hare's fur varies from pure white to gray, brown and light blue, and also changes seasonally according to the time of the year. In winter, it is white while in summer it is brown or gray or light blue to blend with the surroundings. Hares feed on plant material only. Unlike rabbits, hares do not live in groups.

The body of a hare is divided into head, neck and trunk, and has a short tail. The head bears a snout which is wider than that of a rabbit and the external ears are also much longer than those of a rabbit. The external ears also bear black tips. Unlike a female rabbit, which gives birth to five to eight young ones at a time, which are inactive, hairless and with closed eyes, a female hare gives birth to two young ones only at a time, which are very active, with hair and with open eyes.

Lion

Lions are carnivorous (flesh-eating) mammals which live in open country and thin dry forests in eastern Africa and India only. They measure between 1.6 and 2.3 metres in length and live in family groups called **prides**. They have tufted tails. Their cubs are spotted but the spots gradually disappear as they grow older. The male lions grow a **mane.** They have five toes on each forefoot and four toes on each hind-foot. They walk and run on their toes. The toes bear powerful claws.

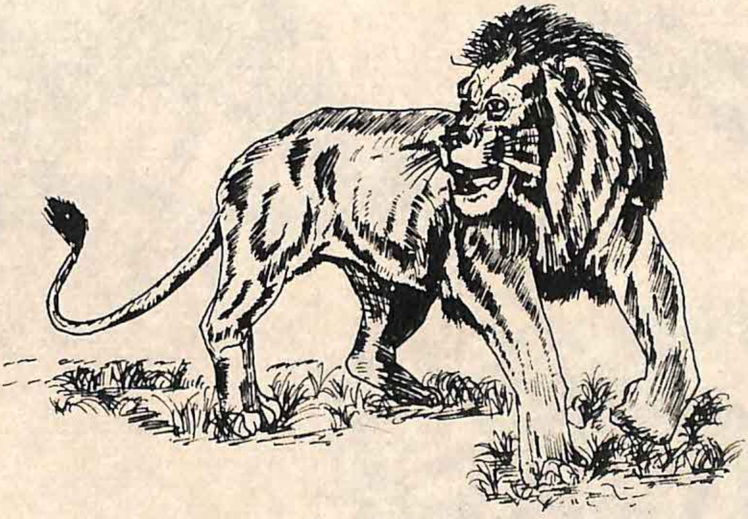


Fig. 13.2 A lion

Tiger

Tigers are carnivorous mammals which are found in thick forests in Iraq, Siberia, Korea, India and Malaysia only. A tiger measures about 2.8 metres in length. It has a brownish coat of hair with black or dark brown stripes (Fig. 13.3). A tiger normally does not attack man. However a wounded and sick tiger may do so. Like a lion, it cannot climb a tree.

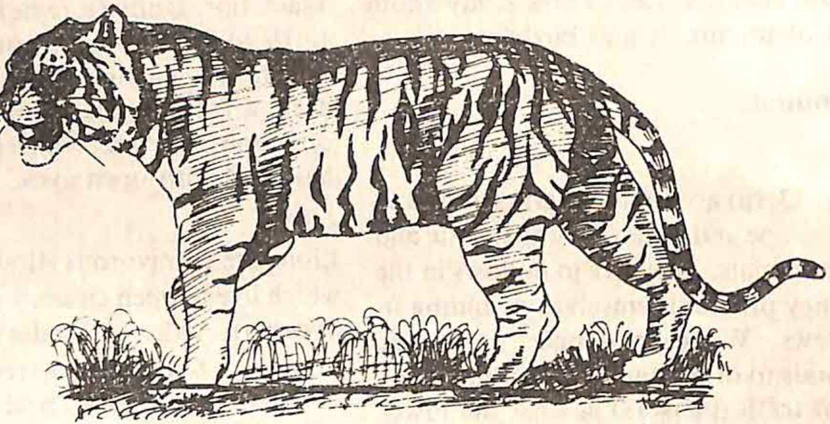


Fig. 13.3 A tiger

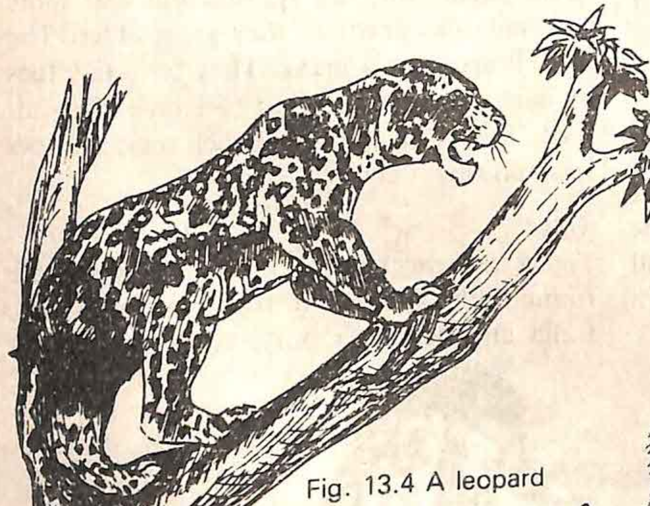


Fig. 13.4 A leopard

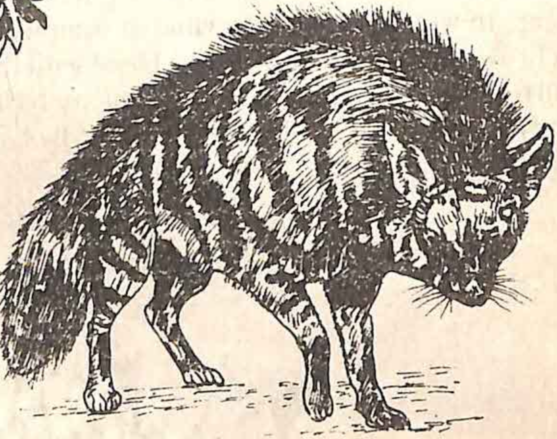


Fig. 13.5 A hyena

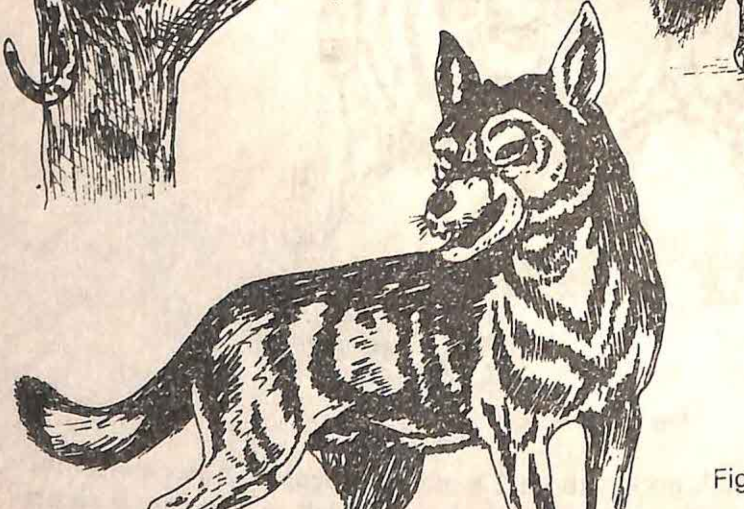


Fig. 13.6 A wolf

Leopard

Leopards are carnivorous mammals found in thick forests of Asia and Africa only. They measure about 2 metres in length and vary in colour from tawny to black with dark patches. Black lepoards are often called **panthers.** Leopards are good climbers (Fig. 13.4) and swimmers. A leopard often lies in wait on the overhanging branches of trees, and just drops down on an unwary animal passing by.

Hyena

Hyenas are carrion eaters and feed on the kills of other animals. They are found in Africa, Arabia and India only and measure about 1.3 to 1.5 metres. They make noises that resemble crackles, cries and laughs. The body of a hyena slopes forward because the forelegs are longer than the hindlegs (Fig. 13.5). They have four toes on each foot. They have the strongest jaws of all animals and can even chew bones.

Wolf

Wolves (Fig. 13.6) are carnivorous mammals found in open country and in the forests of North America, Europe and Asia only. The male measures about 1.3 metres and is longer than the female. They hunt in big groups called **packs.** They surround their prey before they close in to attack.

Fox

Foxes are nocturnal carnivorous mammals found in the woodlands of Asia, Europe, northern Africa and North America only. A fox is about 70 cm long and is smaller than the wolf (Fig. 13.7). They vary in colour from brownish-red to grey and black. Arctic foxes become white in winter.

Jackal

Jackals are nocturnal mammals found in Africa and Asia only and measure between 50 and 80 cm (Fig. 13.8). They feed on any small animal and on the left overs of animals killed by lions and tigers.

Bear

Bears (Fig. 13.9) are omnivorous mammals found in the northen hemisphere, south-eastern Asia, South America, India, Sri Lanka and Arctic regions. They measure from 1.3 to 2.7 metres. Although they look clumsy, they can move very swiftly. Their feet are broad and flat, with five clawed toes on each foot. They walk with their feet flat on the ground. They have

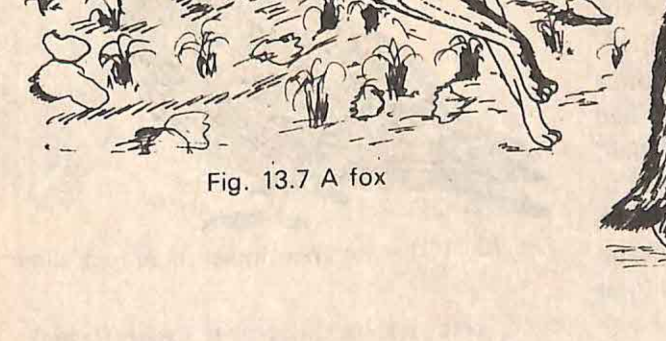


Fig. 13.7 A fox

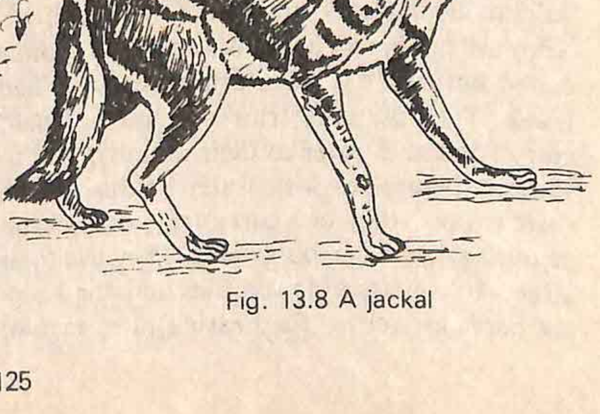
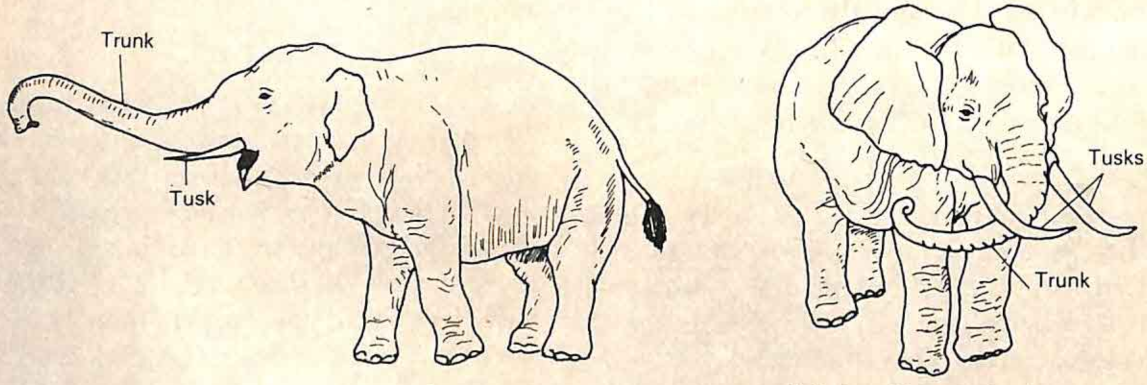


Fig. 13.8 A jackal

Fig. 13.9 A bear

poor eyesight. Their senses of smell and hearing are very keen. They have powerfully built bodies, strong and thick limbs and short tails. Some of them can swim and climb also. Their colours vary from white to brown and black.



(a) An Indian elephant

Fig. 13.10

(b) An African elephant

Elephant

Elephants are the largest of land animals. They are herbivorous and are found in south-eastern Asia, India and Africa only. The African elephant is about 3.2 metres high while the Indian elephant is about 2.8 metres high. They are intelligent animals and live in groups called **herds.** They have a long snout called **trunk.** They use their trunks to touch, smell, carry food and water to their mouths, and to shower themselves with water or dust. With their trunks, they can carry trees or pick up peanuts from a person's hand. They use their large ears for fanning off flies and for keeping cool, as well as for hearing. The ears of African elephants are bigger than those of the Indian elephants. Their upper incisor teeth project from their mouths as **tusks,** in male as well as in female.

13.2 Birds

The body of a typical bird like the pigeon (Fig. 13.11) consists of a head, neck, trunk and tail. The entire body, except a part of the legs, beak and feet are covered with feathers. Of what use are the feathers to a bird?

The head is rounded and bears a beak in front. On either side of the beak and at the base of its upper part, is a swollen patch of featherless skin called the **cere.** At the base of each cere lies a nostril through which it breathes. The head also bears eyes and open-

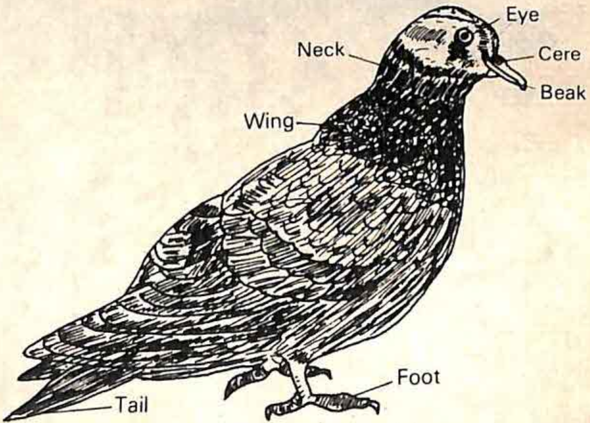
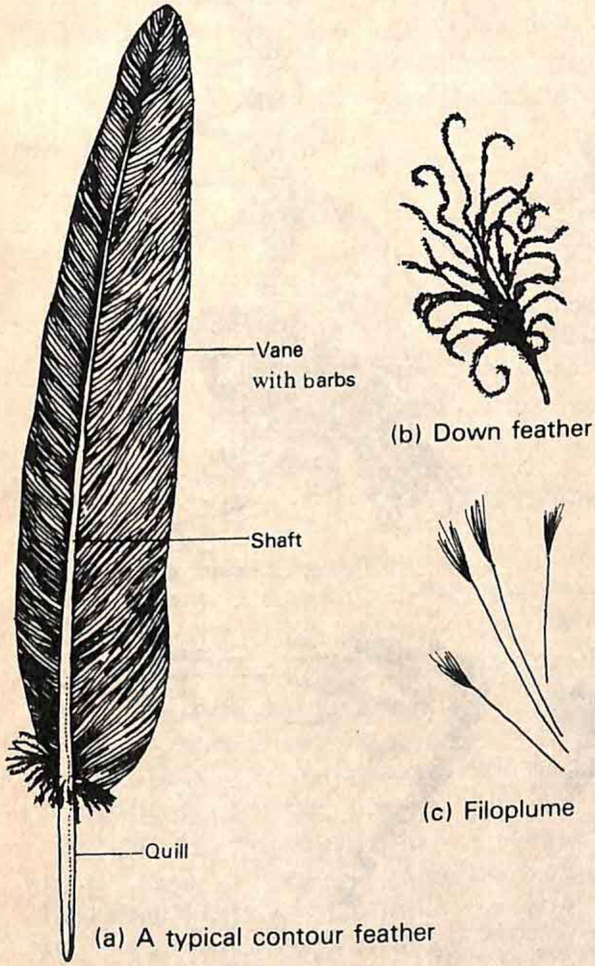


Fig. 13.11 The common Indian blue rock pigeon

ings of the ears. The trunk bears the wings and the legs. The wings are the modified forelimbs. The tail at the end of the trunk is extremely short. The tail helps the bird to change its direction during flight. At the base of the tail, on its under side is the **cloacal aperture,** through which the bird passes urine, faeces and genital products. On the upper side of the tail is an oil gland. The bird uses its oily secretion for preening (cleaning and smoothening with the beak) the feathers.

Plumage and Feathers

Birds show a remarkable variety of colours on their bodies. The plumage of peacocks, pelicans, flamingoes, pheasants, parakeets, kingfishers, birds of paradise, etc. have always been admired by man.



(a) A typical contour feather

(b) Down feather

(c) Filoplume

Fig. 13.12

In some birds, the plumage is protective and blends with the surroundings and enables the birds to escape attention of their natural enemies. The green parrots, for example, sitting amongst the branches and leaves of a tree cannot be easily seen by its enemies.

You must have noticed the feathers of birds lying almost everywhere. This is because the birds **moult** or shed off their old feathers regularly and grow new ones. Some birds, especially males, put on a plumage of brighter colours during breeding seasons.

There are three types of feathers on the body of a bird (Fig. 13.12).

(i) *Contour feathers,* which cover the head, neck, trunk, wings, tail and major portion of legs. Contour feathers on the wings and tail are particularly large.

(ii) *Down feathers,* which are situated close to the surface of the body and are hidden in between the contour feathers. They are much smaller than contour feathers.

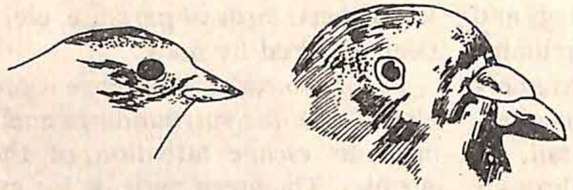
(iii) *Filoplumes,* which are also situated close to the surface of the body and are hidden in between the contour and down feathers. These are much smaller than contour and down feathers.

Structure of a Feather

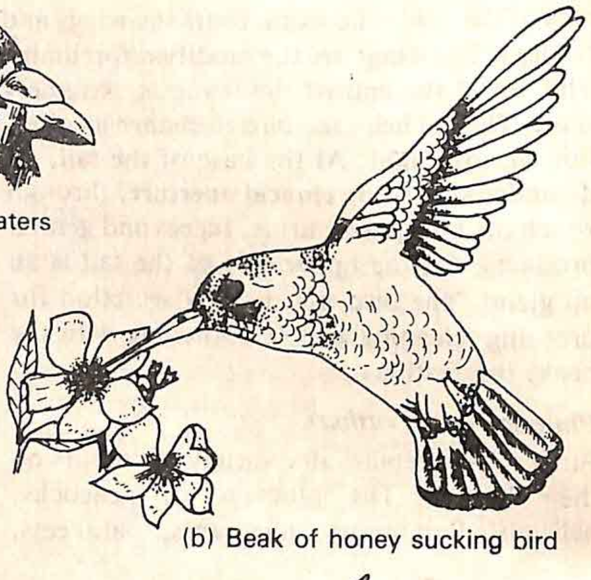
A feather (Fig. 13.12a) consists of a hollow lower part called **quill** and a solid upper part called **shaft.** The shaft bears a number of branches called **barbs** on either side. On either side, a barb bears a number of finer branches called **barbules.** Small hooklets and ridges on the barbules interlock the adjacent barbs and barbules to provide an unbroken surface and flexibility to the **vane.**

Flight in Birds

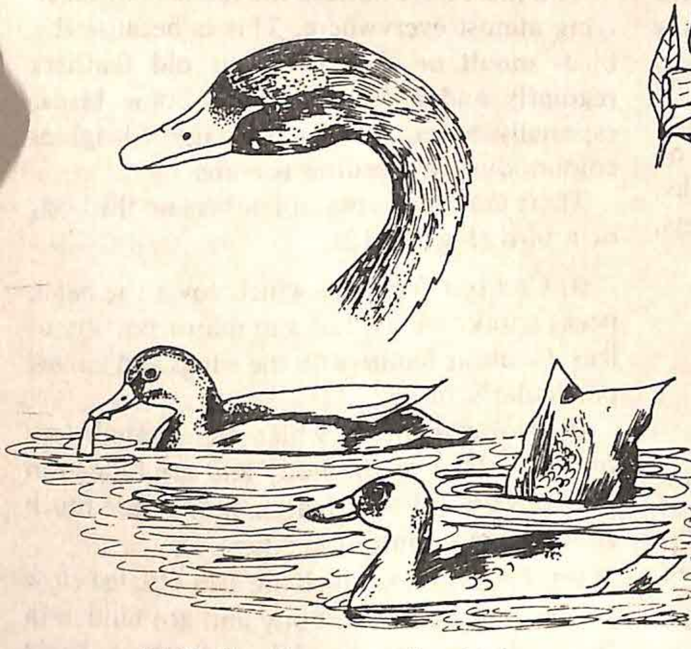
Besides feathers and wings which help the birds in flying, there are other adaptations of birds to flight. Some of these are as follows.



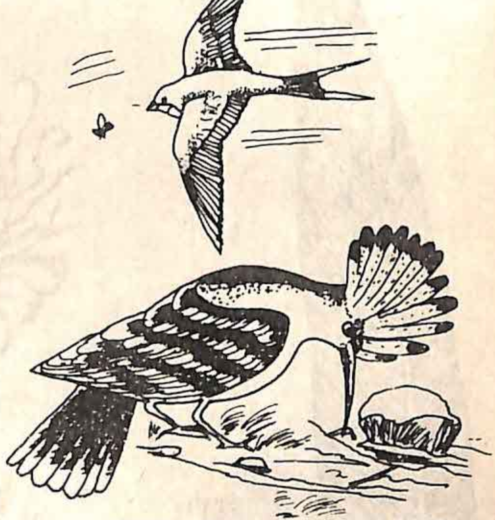
(a) Beaks of seed and grain eaters



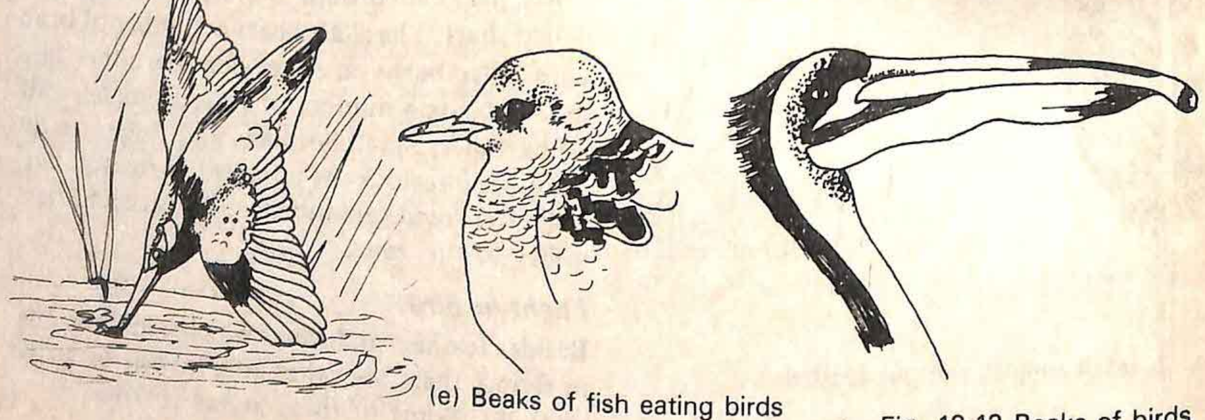
(b) Beak of honey sucking bird



(c) Beaks of worm eating birds



(d) Beaks of insect eating birds



(e) Beaks of fish eating birds

Fig. 13.13 Beaks of birds

(i) The shape of a bird's body is **streamlined** or boat-shaped. Do you know of any other structure with a streamlined shape? This shape helps the birds to steer themselves through the air easily and with minimum air resistance, just as a boat steers through the water.

(ii) Birds have light, hollow and air-filled bones which makes their body very light in weight.

(iii) The strong chest muscles help the birds to fly long distances without getting tired.

(iv) Birds have no teeth and this also makes their body light in weight.

Feeding Habits of Birds

Birds feed on a variety of foods and their beaks are modified and adapted according to their feeding habits. The beak of a bird gives an indication of the type of food it eats, how it gets its food, and how the beak is useful in protecting the bird (Fig. 13.13)..

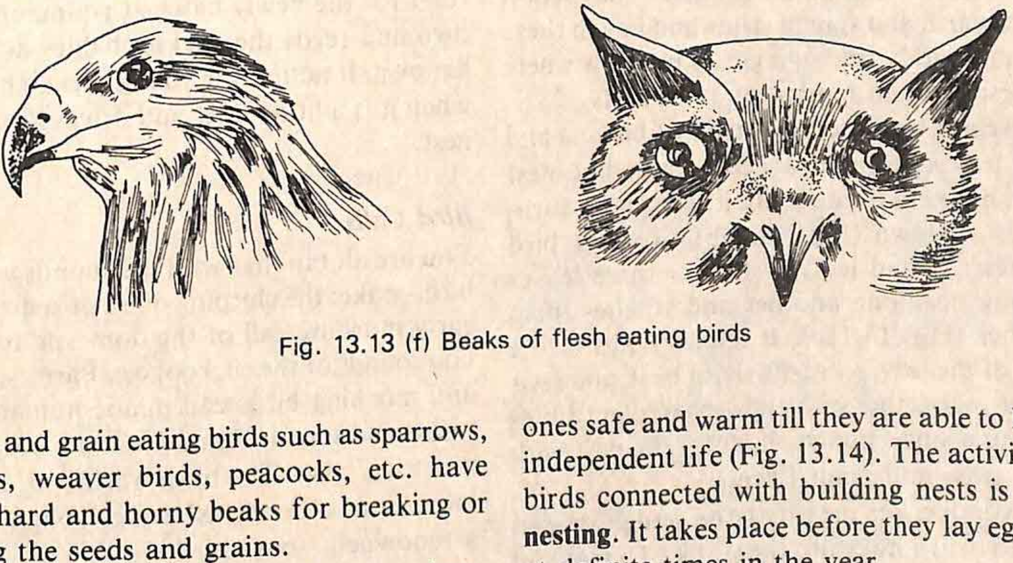


Fig. 13.13 (f) Beaks of flesh eating birds

Seed and grain eating birds such as sparrows, pigeons, weaver birds, peacocks, etc. have short, hard and horny beaks for breaking or shelling the seeds and grains.

Nectar sucking birds such as honey suckers, humming birds, etc. have long straw-like beaks for sucking nectar from flowers.

Worm eating birds such as ducks and swans have flat beaks with strainers along their edges, which look like rows of tiny teeth. They strain worms and water plants from the mud and water.

Insects eating birds such as swallows have broad beaks, a wide mouth and a sticky tongue to help them snap up the insects. Hoopoe has a pincer beak for pulling out insects from their hiding places such as holes in the ground. A woodpecker has a strong, heavy and long beak for pecking the surface of a tree to search for insects.

Fish eating birds such as kingfishers, pelicans and gulls have long beaks for catching fish. Most of them also have long necks.

Flesh eating birds such as eagles, vultures, owls, hawks, etc. have hard, sharp and curved beaks for tearing flesh.

Nesting Habits of Birds

You must have all noticed the birds picking up grass, straw, twigs, threads, leaves, feathers, etc. with their beaks and carrying them to their nesting places. The nests are made by birds in preparation to lay eggs and to keep their young ones safe and warm till they are able to live an independent life (Fig. 13.14). The activities of birds connected with building nests is called **nesting**. It takes place before they lay eggs and at definite times in the year.

At bird chooses its nesting place well out of the reach of its enemies and where it can provide the food to young ones most conveniently. Birds such as crows and sparrows whose young ones are born blind and featherless, build a deep cup-shaped nest at a great height to save the eggs and young ones from falling

Fig. 13.14 A bird looking after its young ones in a nest

(Fig. 13.15a). Birds such as fowls and patridges build shallow nests on the ground. They scoop out the earth and spread straw and hay in these nests in a paddy field or a grassy meadow where the nests remain hidden by tall plants.

A weaver bird uses fine strips of banana and palm leaves to build a deep cradle-like nest which hangs like a pot with its long neck turned upside down (Fig. 13.15b). A tailor bird chooses a broad leaf, or two or three leaves growing near one another and stitches them together (Fig. 13.15c). It makes holes in the edges of the leaves with its sharp beak and sews the leaves together with cobwebs or plant fibres to form a small pouch. It stuffs the nest with dried grass and plant fibres.

A woodpecker uses its large wedge shaped beak to drill a hole into the trunk of a tree and builds a nest there (Fig. 13.15d). The parrots, owls and hornbills also select hollows in tree trunks for building their nests.

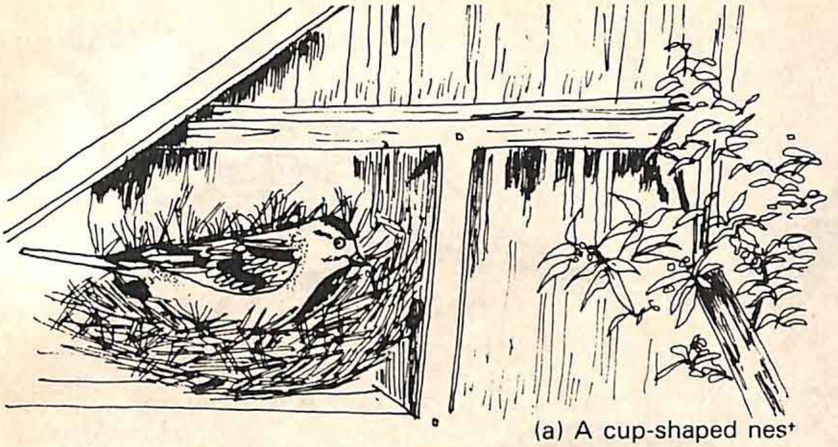
A cuckoo has a very unusual nesting habit. The female cuckoo bird finds the nest of another bird, steals one of the eggs from the nest, lays her own egg and then flies off with the stolen egg. The owner of the nest brings food for the newly hatched young ones of its own and feeds the cuckoo babies along with her own. It notices the young cuckoo baby only when it is a little older and drives it out of the nest.

Bird Calls

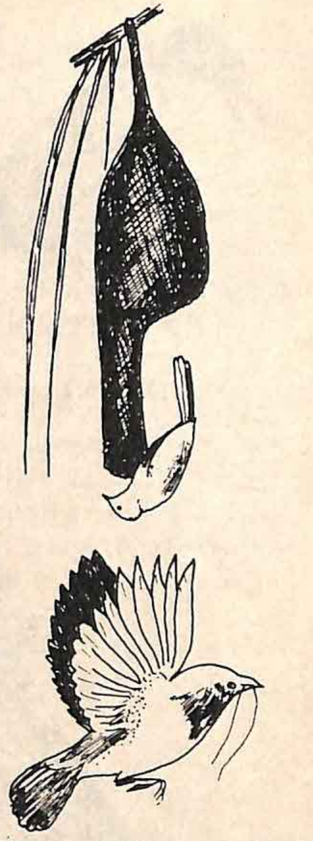
You are all familiar with the sounds which the birds make: the chirping noise of sparrows, the early morning call of the domestic fowls, cukoo sounds of the cuckoo, etc. Parrots, mynahs and mocking birds can mimic human voices, words and sounds. Thrushes and mocking birds can 'sing' also. The bush warbler is an expert imitator of other birds' 'songs'. Nightingale is a renowned 'song' bird.

Bird calls, 'songs', cries, screams, etc. are for

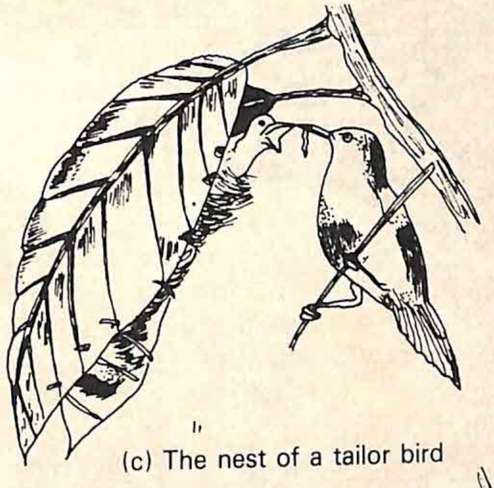
(a) giving a signal to other birds that there is danger,
(b) calling the young ones,
(c) attracting attention of the parent birds,
(d) attracting female birds' attention for breeding, etc.



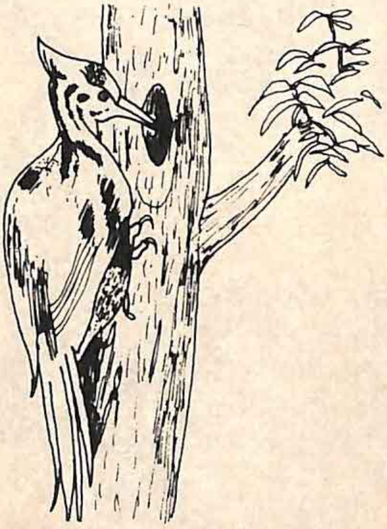
(a) A cup-shaped nest



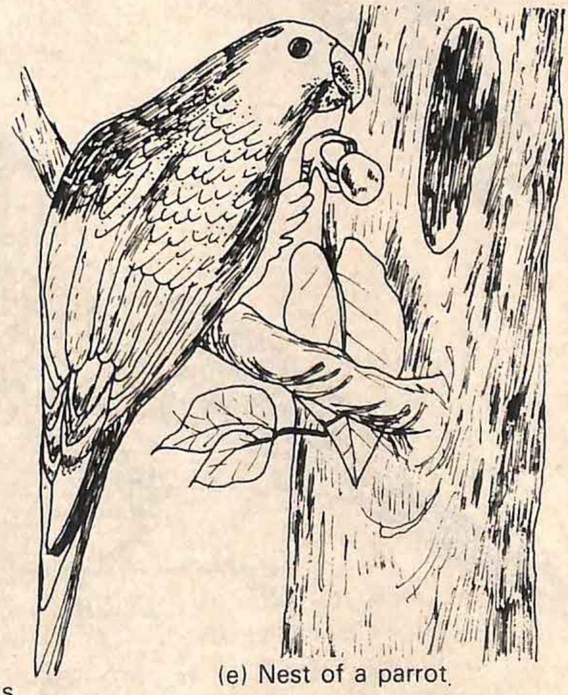
(b) The nest of a weaver bird



(c) The nest of a tailor bird



(d) A woodpecker's nest



(e) Nest of a parrot

Fig. 13.15 Nests of birds

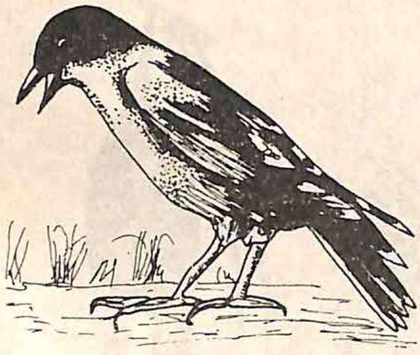


Fig. 13.16 A king crow

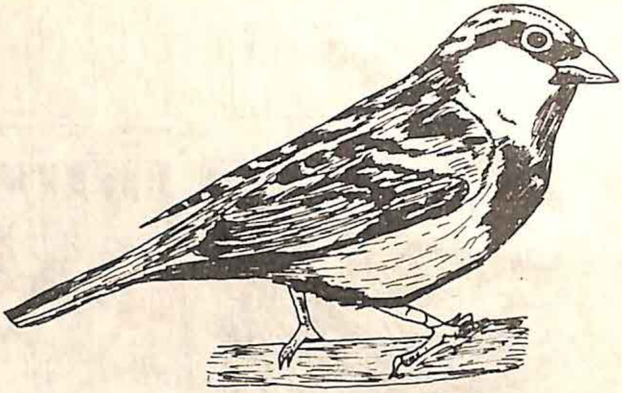


Fig. 13.17 A house sparrow

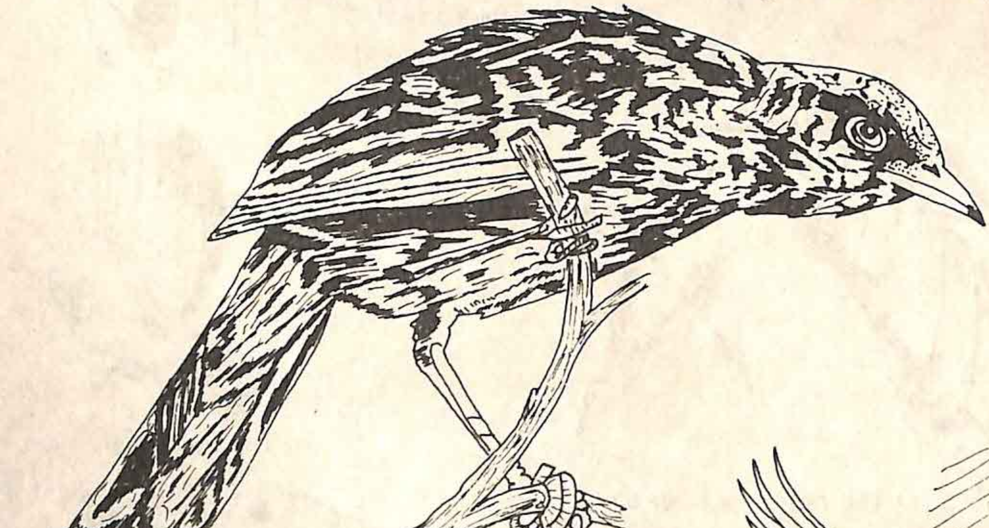


Fig. 13.18 A babbler

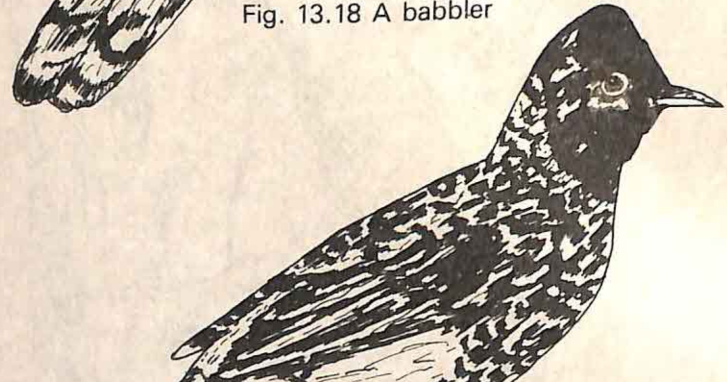


Fig. 13.19 A red vented bulbul

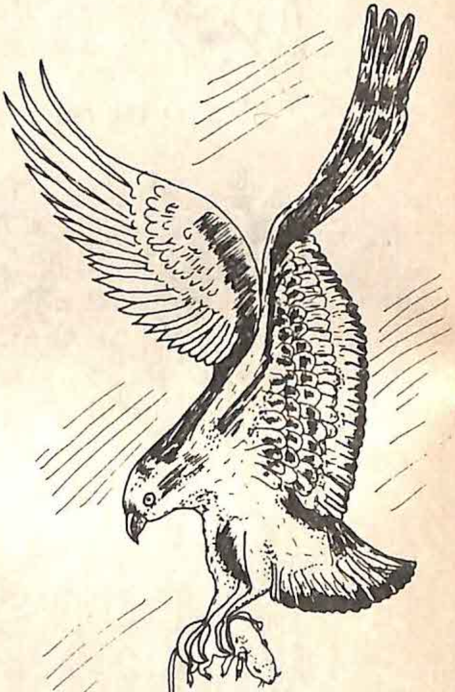


Fig. 13.20 Hawk preying on a small mammal

13.3 Some Common Birds

King Crow

It is found in most parts of India. It inhabits the open countryside near places where man lives. It has a black plumage and measures about 45 cm (Fig. 13.16). It feeds mainly on insects but takes anything man offers to it. It also feeds on the remains of the kills of other animals. In what way is this animal useful to farmers?

House Sparrow

It lives very successfully at all places inhabited by human beings. It measures about 15 cm (Fig. 13.17). It feeds mainly on grains and seeds.

Parrot

It has a green plumage with a strong red hooked beak (Fig. 13.15e). It feeds on ripe or semi-ripe fruits. The movable upper part of its beak helps it in climbing trees. Its fleshy tongue helps it to mimic words and sounds. Parrots live in groups and make their nests in hollows of trees.

Babbler

These are found in the forests all over Australia, Africa and Asia. They are about 10-25 cm long and have a soft and fluffy plumage of dull brown colour (Fig. 13.18). They are noisy birds. They feed on insects, seeds and grains. They are usually seen in groups of seven and are therefore also called seven sisters.

Bulbul

It lives in trees in southern Asia and Africa and feeds on fruits and occasionally on insects. It has a plumage of smoky brown colour and measures about 20 cm. It has a partially crested head and a distinct red coloured patch under the tail.

Tailor Bird

It is found all over India, Sri Lanka and Malaysia and measures about 12 cm (Fig. 13.15c). You have already learnt about the nesting habit of this bird.

Hawk

It is a large bird of prey which is a swift and strong flier (Fig. 13.20). It has powerful and sharp claws and a hooked beak. It feeds on small mammals and birds and is also capable of preying on animals larger than itself.

Wagtail

It is found abundantly in Europe, Asia and Africa. It has a slender body and can walk and run rapidly. It keeps on pumping its tail up and down at all times. It is a strong flier too. It feeds on insects and lives near water and in swampy meadows. It builds a delicate nest on the ground. The blue headed wagtail measures about 16 cm and has a blue gray plumage on its upper side and a bright yellow plumage on its under side.

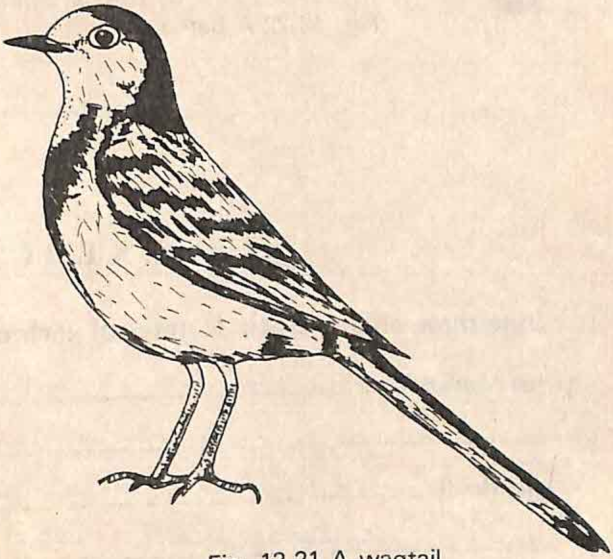


Fig. 13.21 A wagtail

Woodpecker

It climbs trees with the help of its sharp claws and a short tail which acts as a support against tree trunks (Fig. 13.15d). It cuts through the bark of a tree to locate insect larvae with the help of its large wedge-shaped beak. It also uses its long and sticky tongue to search for the larvae hidden under the bark. The black woodpecker is about 25 cm long and is found in the forests in Europe, Siberia and some parts of Asia.

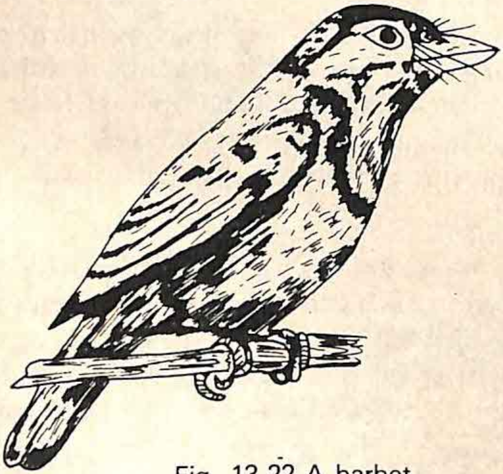


Fig. 13.22 A barbet

Barbet

It lives on trees in the forests in all tropical countries. It has a short neck and a big head. Its beak is heavy and has bristles around it. The golden throated barbet (*neel kanth*) is about 23 cm long.

Hoopoe

It is an attractive bird found in Europe, Asia and Madagascar. It has a black tipped crest on the head which can be erected or flattened. It runs fast and finds most of its food on the ground. Its food consists of worms and ants.

EXERCISES

1. State three characteristic features of each of the following.

(a) Mammals ______________________________

(b) Birds ______________________________

(c) Hyena ______________________________

(d) Bear ______________________________

(e) Hawk ______________________________

(f) Woodpecker ______________________________

2. State two differences between each of the following pairs.

(a) Rabbit and hare ____________________

____

____

(b) Indian and African elephant ____________________

____

____

(c) Tiger and leopard ____________________

____

____

3. What are the special structures which enable a bird to fly efficiently? ____________________

____

____

4. How do the following help the birds.

(a) Bird calls ____________________

____

____

(b) Beaks ____________________

____

____

5. Name the three types of feathers on the body of a bird. ____________________

____

6. State whether the following statements are true or false.

(i) A hare's fur can change colour.

(ii) Both male and female lions have a mane.

(iii) A tiger can climb trees.

(iv) Some foxes are white in colour.

(v) Jackals come out only during the night.

(vi) Bears eat both animals and plants.

(vii) Elephants eat flesh of small animals.

(viii) Birds breathe through the cloacal aperture.

(ix) Nesting may take place at any time of the year.

(x) A cuckoo builds a cup-shaped nest.

7. Fill in the blanks.

(i) Lions live in family groups called ____________________.

(ii) Black leopards are called ____________________.

(iii) Wolves hunt in groups called ____________________.

(iv) The ____________________ shape of a bird's body helps it to fly.

(v) ____________________ and ____________________ are fish eating birds.

(vi) Hard, sharp and curved beaks are possessed by ____________________ eating birds, for example ____________________.

(vii) The ____________________ bird stitches leaves together to build its nest.

(viii) Two birds which live in hollows of trees are ____________________ and ____________________.

(ix) ____________________ are also called seven sisters.

(x) The bird which keeps on pumping its tail up and down at all times is ______.

Middle School Science

Science - Class 6
Physics - Classes 7 & 8
Chemistry - Classes 7 & 8
Biology - Classes 7 & 8

This series of four text-cum-workbooks offers a complete course for Classes 6, 7 and 8 along the guidelines laid down by the ICSE and the NCERT.

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